









THE  
SCIENCE OF COTTON SPINNING

PRACTICALLY ARRANGED AND SIMPLIFIED



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THE SCIENCE  
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PRACTICALLY ARRANGED AND SIMPLIFIED.

GIVING A PLAIN, PRACTICAL, AND COMPREHENSIVE DETAIL OF THE VARIOUS DEPARTMENTS  
OF BLOWING, CARDING, DRAWING, SLUBBING, INTERMEDIATE, ROVING, AND SPINNING,  
UP TO 350 HANKS IN THE POUND, EMBRACING SEVERAL KINDS OF YARNS—SUCH  
AS COMMON, EXTRA, AND SUPER-EXTRA TWIST;

WEFT, DOUBLING, AND HOSIERY YARN, WITH THE PROPER SIZE OF ROVING FOR EACH KIND  
AND COUNT;

LIKEWISE, THE TWIST PER INCH IN THE ROVING, AND THE DIFFERENT KINDS AND  
COUNTS OF YARN.

GIVEN IN A SERIES OF RULES AND TABLES, CONTAINING MUCH ORIGINAL MATTER NOT TO BE  
FOUND IN ANY FORMER PUBLICATION TREATING ON COTTON SPINNING.

BY  
JAMES HYDE.

NEW EDITION, REVISED AND CORRECTED.

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## P R E F A C E .

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THE following treatise is submitted to the Proprietors of Cotton Mills, Managers, Machine-makers, Overlookers, Mechanics, and all others in connection with the business who may be desirous of gaining a thorough knowledge of Cotton Spinning. Popular works upon Practical Cotton Spinning have become so numerous of late that it might be supposed any attempt at further illustration would only be an unnecessary repetition of former matter ; and that if possessed of any one work upon the subject another is not required. Such, however, is not the case ; for, although there are many former publications on Cotton Spinning, there is still ample room left for the introduction of this.

Having in the course of my experience been frequently in want of ready practical rules, and as often disappointed, after having referred to works in which I expected to find the required information, I made it my business to supply the wants as I found them—at any rate, as far as I considered it necessary for my own purpose ; and being sanguine enough in my own mind that I should be able to remove many difficulties and bring into practice such improvements as are desirable and necessary in conducting the operations of Cotton Spinning, I have in the course of this work brought within the reach of old and young all the information requisite for qualifying themselves for any or every branch in connection with the Art and Science of Cotton Spinning ; so that any person having acquired a good knowledge of common arithmetic may, with a little perseverance, hope to gain (with honour to himself and profit to his employer) a situation as Manager of a Cotton Mill. Originally much of this treatise was arranged, for my own private use and convenience, as a sort of reference in case of need ; but as the work progressed and began to develop its form (at once both simple and comprehensive) it became evident to some of my most particular friends, who appreciated its utility, that it should be



made as complete as possible, and I was strongly urged to proceed with it, and let the public have the benefit of gaining a thorough knowledge of Cotton Spinning much sooner, by having a guide to assist them, than having to work and toil through years of study and practice before arriving at the knowledge requisite, and perhaps at the last lose all hope and give up in despair. It is to be hoped that these few pages will have the effect of creating a confidence that will support them until the prize be gained.

The tables may easily be understood by tracing the counts of yarn step by step through all the different machines, viz., Carding, Drawing, Slubbing, Intermediate, Fine Roving Frames, and Mules. The counts of yarn will be found at the top of each table which it is intended to prepare for; and changed as often as it is deemed necessary, to accommodate the numbers of yarn to be spun, without deranging the draught materially.

The plan of the work is practically arranged, and may be relied on with confidence.

The Author has had opportunities of gaining a knowledge of Cotton Spinning that fall to the lot of very few, being himself practically acquainted with Cotton Spinning and the making of all kinds of machinery for the same; so that if practical experience be any guarantee for the merits of this work he has had upwards of fifty years of such experience, and during the greatest part of the time has held important and responsible situations in connection with Cotton Mills.

Should this little work prove useful to those for whom it was intended, and in any way assist them in gaining a competent knowledge of Cotton Spinning, then let its usefulness apologise for its imperfections, and the wishes of the Author will be accomplished.

JAMES HYDE.

WHITFIELD, NEAR GLOSSOP.



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# THE SCIENCE OF COTTON SPINNING.

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## VARIOUS QUALITIES OF COTTON.

COTTON is generally distinguished by its colour, and the length, strength, and fineness of its fibres. There are many varieties of cotton, their names being principally derived from the countries where they are cultivated; also, under each general name, there are various denominations, distinguished by the particular province or district of the country where they are grown. East India cotton includes Surat, Bengal, Madras, Bourbon, &c. The latter takes its name from the Isle of Bourbon in the Indian Ocean, where it is cultivated. It is generally a very superior cotton, both for strength and fineness, although short in the staple. There are other kinds of East India cotton, of a very low quality. They have a fine glossy and silky appearance, but are extremely short in the staple and are used only for spinning the lowest numbers of yarn. The West India cotton, in price, ranks with Upland and the common and middling qualities of Orleans. This cotton is various in its qualities, but in general is a strong, coarse article, irregular in its staple, and well adapted for the manufacture of the stouter fabrics of cloth, to which it is mostly applied, but it is totally unfit for fine goods. South American cotton includes that imported from Brazil and Guiana. Brazil cottons are distinguished by the names of Pernambuco, Maranhão, Bahia, Para, Maceio, according to the districts where they are grown. That known by the name of Pernambuco is of a fine rich cream colour, and of a superior quality; it long had the reputation of being superior to any imported—Bourbon and Sea Island excepted. In quality Pernambuco ranks with Egyptian; the latter is finer, but very irregular. Maranhão, Bahia, Para, and Maceio wools partake much of the same general description, but are inferior both in strength and cleanness. The cottons imported from the coast of Guiana are distinguished by the names of Demerara, Berbice,



Surinam, Cayenne, Essequibo, &c. Demerara cotton is a strong, glossy wool, pretty long, though unequal in the fibre, and generally well cleaned and picked before it is packed. It makes a clean, stout thread, and is frequently used for fine weft or warps of a moderate fineness. It is rather coarse for the finest qualities of either. It is usually classed with Berbice, but the latter is considered rather inferior. In price and quality they rank with Egyptian and Pernambuco wools. Essequibo is something similar to those mentioned, but inferior. Cayenne cotton is not much imported. It is, like Demerara, a clean wool, but very long and hard in the staple, which makes it difficult to card and spin. Surinam resembles Demerara and Berbice in appearance, but is inferior both in strength and fineness, and similar to the Essequibo. Both of them are considered to be pretty much on a level in quality with the West India wools. Egyptian, from Sea Island seed, stands next in quality to Sea Island cotton, but is inferior in fineness and regularity of staple. It is much used in the higher numbers of yarn along with Sea Island. The common Egyptian ranks with Brazilian cotton, and both are used for adding strength to inferior cotton in the lower counts of yarn. Cotton from the United States of North America is generally distinguished by the names of Sea Island, Upland, New Orleans, Alabama, Tennessee, Mobile, &c. Sea Island cotton is the finest known. Upland cotton is a different species from Sea Island, and is grown in Virginia, North and South Carolina, and Georgia, and is more suitable for weft than warp. New Orleans is a very superior cotton, clean, and of a silky appearance. Rather short in the staple it incorporates freely with cotton of longer staple. Mobile is a similar cotton, but not so clean and silky as New Orleans.

The following table shows the approximate length of staple suitable for all counts of yarn from 10 to 350 hanks in the pound :—

| Counts. | Staple.         | Counts. | Staple.         | Counts. | Staple.         | Counts. | Staple.         | Counts. | Staple.          | Counts. | Staple.          |
|---------|-----------------|---------|-----------------|---------|-----------------|---------|-----------------|---------|------------------|---------|------------------|
| 10      | $\frac{23}{32}$ | 22      | ...             | 42      | ...             | 80      | $1\frac{3}{32}$ | 160     | $1\frac{7}{32}$  | 260     | $1\frac{3}{8}$   |
| 11      | ...             | 24      | $\frac{7}{8}$   | 44      | ...             | 85      | ...             | 170     | ...              | 270     | ...              |
| 12      | $\frac{3}{4}$   | 26      | ...             | 46      | ...             | 90      | ...             | 180     | $1\frac{1}{4}$   | 280     | $1\frac{13}{32}$ |
| 13      | ...             | 28      | ...             | 48      | ...             | 95      | ...             | 190     | ...              | 290     | ...              |
| 14      | $\frac{25}{32}$ | 30      | $\frac{29}{32}$ | 50      | 1in.            | 100     | $1\frac{1}{8}$  | 200     | $1\frac{9}{32}$  | 300     | $1\frac{7}{16}$  |
| 15      | ...             | 32      | ...             | 55      | ...             | 110     | ...             | 210     | ...              | 310     | ...              |
| 16      | $\frac{13}{16}$ | 34      | $\frac{30}{32}$ | 60      | $1\frac{1}{32}$ | 120     | $1\frac{5}{32}$ | 220     | $1\frac{5}{16}$  | 320     | $1\frac{15}{32}$ |
| 17      | ...             | 36      | ...             | 65      | ...             | 130     | ...             | 230     | ...              | 330     | ...              |
| 18      | ...             | 38      | ...             | 70      | $1\frac{1}{16}$ | 140     | $1\frac{3}{16}$ | 240     | $1\frac{11}{32}$ | 340     | ...              |
| 20      | $\frac{27}{32}$ | 40      | $\frac{31}{32}$ | 75      | ...             | 150     | ...             | 250     | ...              | 350     | $1\frac{1}{2}$   |



## ON COTTON MIXING.

The first operation of a cotton mill is to open up the bales for mixing, for which there are various methods, all aiming to keep up a proper quality of staple suitable for the yarn intended to be made from it.

The following system is used by many establishments: Take ten, twenty, or thirty bales, according to the size of the mixing; bring them one by one and lay them on the side, cut off the ropes or hoops, then turn them on the edge and take off the upper part of the tare, place them side by side or otherwise, as convenience may dictate; that being done the quality should be seen by the manager, as the most competent and responsible person, as it is very desirable to keep a uniform quality. He will see the necessity of withdrawing a few bales, as superior or inferior quality may prevail. It is well to have in store a few bales of each kind ready for the purpose of rectifying the quality. The mixing ought to be superintended by some trustworthy person, whose duty would be to see that justice is done to the mixing by the work-hands. The bales should be taken alternately, superior and inferior, and one or two persons should take the cotton by armsfull and throw it on the space allotted for the mixing, while others are shaking it open and spreading it evenly over the surface, at the same time treading well down, in the same manner as in making a haystack; when all the bales are put on trim the sides and ends of the mixing by pulling out all the loose hanging cotton, and throw it on the top while the hands are yet treading it down. This, then, may be called a finished mixing.

Some kinds of cotton do not incorporate satisfactorily, on account of being in hard clotted lumps, so that it becomes necessary to put it through the cotton-opener before mixing. The following kinds of cotton are more or less of this description: Egyptian, Maranhão, Pernambuco, Bahia, Maceio, &c. Surat, and other East India cotton of short staple, having undergone very high pressure while it is in a damp state, when the bales come to be opened, is found in hard bits and lumps matted together as hard as wood, and is not in a fit state for mixing until it has been put through the willow.

## THE WILLOW.

The common willow is a very useful machine for opening Surat, and other cotton of that description. It is much in favour with the waste dealers, and in a modified form is used as a general cotton opener at some mills. The willow is of Norman origin,



and its name is derived from the fact of the grating under the beater being made of willow twigs.

The conical willow was first made in a simple form by Mr. Benjamin Brundred, of Oldham, near Paterson, in the State of New Jersey, North America. After its introduction into England it was considered to be very much improved, and it was in great reputation for a time, but there are few, if any, now in use.

### THE COTTON OPENER.

The most approved form of this machine is that with four cylinders or beaters, each cylinder having six or eight rows of flat teeth, projecting about two and a half inches from the cylinder, and are about two wide and two and a half inches apart; these are made of Bessemer steel, and cast in rows on a bar or segment equal to the length of the cylinder. A cylinder of two feet diameter may revolve at the rate of about one thousand times per minute. The circular grating under the cylinders should clear about an eighth of an inch. By being thus near the cotton is lashed open against the grate bars, while the seeds, shells, and other dirt fall through the grating, and the light dust and short fly is drawn through the wire cylinders by the draft of the fan and blown into the dust-room.

The common fluted iron feed rollers never ought to be used in this machine, for various reasons. The heavy pressure put on them, so as to maintain sufficient hold on the cotton, to keep it from being drawn through the rollers by the action of the beater, is quite enough to crush the cotton seeds and press the oil from them, which is quickly absorbed by the cotton, and becomes troublesome in every operation it goes through, in causing the rollers to lap instead of allowing it to pass on, causing great loss in the quantity of work. Seeds so crushed are not so easy to get rid of as when they are unbroken.

Iron rollers, when used in this machine, are subject to being lifted out of gear by irregular feeding, which cannot always be avoided, when it is taken into consideration the quantity of cotton that in some cases has to be put through the machine. To remedy these evils use spiked rollers, with taper teeth or pegs, about three-quarters of an inch long, made of steel, and moderately curved to admit of the beater clearing the cotton from them; let the shaft or body of the rollers be one and three-quarters or two inches diameter, with eight teeth in the circumference, and lengthwise from three-quarters to one inch apart, with the teeth



of the top roller wading between the teeth of the bottom roller, entering to the depth of half an inch.

The more cleaning the cotton gets at this machine the more regular the yarn will be kept in the counts, because the principal part, or nearly all of the extraneous matter will have left the cotton before it comes to be weighed at the first blower or spreader. A cotton opener forty inches wide is able to pass through it about 30,000lb. per week.

The cotton should be taken from the mixing in a regular thin slice, by a tool similar to a gardener's rake, with round taper prongs about three inches long, and about one and a half inch apart.

### THE FIRST SPREADER.

These machines are known under several names, such as scutcher, spreader, blower, and lap machines. The first spreader generally contains two beaters, about eighteen inches diameter, with four blades for beating the cotton from the feed rollers, and revolves at the rate of 1,350 per minute; as the cotton is driven from the beater it is taken up by the suction of the fan and drawn into close contact with the wire cylinder, which carries it forward and delivers it to a pair of calender rollers, where it undergoes great pressure, and is then in a condition to be lapped on a rod to form a lap roller of about fourteen inches diameter. In this state it is ready for the second spreader.

The feeding part is about eight feet long, and the apron or creeper, being double, will, of course, be twice that length, or sixteen feet divided into three equal parts of 5ft. 4in., or any other length, provided they are all equal. They are distinguished by a black mark being made across the apron. Between these marks a certain weighed quantity of cotton is spread as evenly as possible, and as the apron continues moving forward the next length makes its appearance ready to receive another weighing in like manner.

As cotton varies slightly in weight, according as the weather is wet or dry, and as a metal counterpoise is uniform, a variable counterpoise is made by packing with cotton, of the right weight for a feed, a cylinder made of wire gauze, in shape like a stable lantern; as this weight is about as much affected by atmospheric changes as the cotton which is to be weighed an equality is thus preserved in forming the laps.

The weighing machine ought to be placed within a box whose height is on a level with the top of the feeder, so that nothing is



seen above the box but the dish for weighing the cotton in ; the door of the box should be kept locked, to keep anyone from tampering with the counterpoise ; the panel of the door should be of wire gauze, to allow the free circulation of the air.

#### THE SECOND SPREADER.

The use of the second spreader is to prepare lap rollers for feeding the carding-engines, they are generally made two inches narrower than the cards they are intended to supply. They also further mix and equalise the cotton, so as to form a more level and uniform web than can be made at the first spreader, by putting three or four lap rollers from the first spreader together to form a feed for the second spreader, so that it becomes a kind of doubler. The draught in the machine is so arranged as to accommodate the doubling and the weight of feed required for the carding-engine. The lap rollers are formed in the same manner as at first spreader. The second spreader has generally but one beater, which is considered quite sufficient for the purpose of spreading cotton.

#### THE DOUBLER.

The doubler is a very important machine in the middle and finer counts of yarn. It was originally called the Derby doubler. In 1850, or 1851, a patent was taken out for some improvement by Mr. Evan Leigh, and one of these machines was made by the celebrated machinists, Messrs. Platt Brothers, and Co. of the Hartford Ironworks, Oldham ; and was by them exhibited at the great Exhibition of 1851.

Its use is for the purpose of forming lap rollers for feeding the finisher carding-engines, and is considered superior to any other known method for that purpose. It is fed at the back, in a similar manner to the drawing-frame, by putting up from 20 to 40 cans taken from the breaker-cards, and passing the slivers through a conductor, or guide, into the receiving rollers, and thence through the calender rollers to the lap rollers, forming a very smooth and level web, which must be handled with great care to keep the edges from being disturbed, as it is rather a difficult matter to put them right again. It is sometimes found necessary, when the web is not sufficiently close to form a compact sheet, to lap on the roller, with the cotton, a piece of strong smooth linen cloth, the same width as the lap roller, and in length from 20 to 30 yards, or such length as the size of the roller may require. For the higher counts of yarn it is necessary that the rollers should be so lapped with linen cloth ; and when put to the finisher carding-engine the cloth should be allowed to fall into a box placed at the back of the carding-engine for that purpose.



## GRINDING.

Grinding is a branch in carding indispensably necessary, and should be attended to with some degree of skill and judgment. Much depends upon good grinding in producing good carding; for if the grinding be not done to perfection, neither can the setting of the cards be done to perfection. It is therefore necessary that the carder should understand the ways and means of arriving at perfect truth in grinding before he can reasonably be expected to produce first-rate carding. In the first place the grinding cylinders and rollers should be as near perfect as possible. The emery for covering the grinding cylinder is generally what is called No. 4 emery, and for covering the grinding roller No. 5 emery, or one number finer than that for the cylinder. Before the emery is used it should be put into a fine sieve, and water poured over it till the water appears to leave it quite clear, as that is a sure sign that all the dust is washed out of it. When the water is sufficiently drained from the emery it should be put into a very warm or even hot place to dry till it is wanted for use. It should be used while hot, and disturbed as little as possible, or dust will be made again, and this is a great detriment, for it covers the face of the glue in a measure, to the exclusion of the emery, which will cause a great portion of the cylinder to be left bare. Never put a second coat on for the sake of filling it up, for that would be done at the expense of truth; though it may appear rather bare it will do better grinding than if a second coat had been put on. When covering a grinding cylinder have as much emery ready as would serve three or four cylinders. Put it into a triangular box or hopper, with a slit in the lower angle about a quarter of an inch wide and the length of the cylinder. The box should be placed firmly about three-sixteenths of an inch above the cylinder, with a thin board in to shut up the slit, and sufficiently wide to be easily withdrawn when required. Fill in the emery to be in readiness as soon as the cylinder has received a coat of glue all over it; draw out the thin board which acts as a valve to let out the emery through the slit; then turn the cylinder very slowly, and be prepared with a roller to revolve on the emery as it leaves the hopper, so as to press the emery into the glue. It is well to have a knowledge of the quality of the glue before using it. A strong, tough glue, is the best; but if the glue should prove to be brittle it should be strengthened by a little isinglass, so that it may hold on firmly both to the cylinder and emery. The cylinder should receive a coating of red-lead paint, and be allowed to dry perfectly before the glue is put on.

The reason for putting finer emery on the rollers than the cylinders is to keep as near the truth of the roller as possible, and



that the main cylinder and doffer cards can be brought to a needle point by the hand strickle being covered with No. 4 emery, whereas the top cards could not be so pointed by the hand strickle. The grinding of the cards to a needle point is effected by moving the strickle quickly from end to end of the cylinder or doffer, and at the same time keeping it parallel with the axis of the cylinder. In preparing the tops, previous to nailing on the cards, they should be made straight in their length, and rounded across the face to the same circle as the main cylinder. On no account should they be planed to a flat surface, for if they are so planed they are subject to vibrating up and down when put to work, and have to be set off, or the card teeth come in contact with each other and take off the edge or points of the cards, to the detriment of the carding, whereas if the face of the tops be rounded the vibration will be destroyed, so that the top cards can be set closer to the main cylinder with a rounded surface than with a flat surface to the extent of the vibration.

For grinding top cards the following method is recommended, as being well adapted for doing it in a superior manner: Let the grinding machine be provided with radial arms or levers, movable on a stud or joint in connection with slides on the extreme end of the framing of the grinding machine, to be moved by means of screws, and coupled together with a cross shaft and bevel wheels, with a small hand wheel or boss on the cross shaft for turning the screws while setting the tops to or from the grinding cylinder; the ends of the radial arms next to the cylinder should be made for receiving the tops and holding them in a proper position for grinding them equally across the face, whichever side of the top may be uppermost. The radial arms should be about eighteen inches long, from the face of the top to the centre of the stud or joint, the top being held in its place by a set screw, with a washer on the end to keep it from injuring the wood.

The radial arms are moved up and down, not less than the breadth of the face of the top, by being connected with two side levers, moved by two heart wheels on a cross shaft which receives its motion from the cylinder shaft by means of spur wheels. Set the cheeks of the radial arms parallel with the cylinder. That being done, put a top into the machine and grind it to a round face (it having already been brought somewhat near the shape by the hand-plane); when it is ground enough take it out and rub on some colouring matter, in a dry state, and reverse the top—that is, change it end for end, and put it in again, moving it to the cylinder merely to mark it. Take it out again and examine the face. If the cylinder has touched one edge more than the other, or one end more than the other, it requires rectifying by filing the



cheeks against which it rests ; and for making it nearer parallel, turn one of the screws in or out, as the case may be, and couple up again for another trial. Repeat the trial in this manner until perfection is gained, and will grind equally either edge up. When that has been effected the relative position of the radial arms should never be altered—that is, the two ends of the top should move in and out together. After having been once fairly adjusted, put in the tops and grind them to a face. When they are sufficiently ground take them out of the machine and rub them lengthwise with sand-paper. They are then ready for nailing on the cards. When the top cards are put into the machine for grinding, all that is necessary is to fasten them in by the set-screws, and move them to the cylinder by turning the cross shaft that connects the screws of the slides together. For grinding the main cylinder, doffer, and licker-in, there should be proper fixtures for holding a grinding roller, about six inches diameter, quite parallel with the cylinders, with provision for setting in the same manner as for rollers and clearers. There have been several schemes for grinding cylinders and doffers supposed to be superior to the grinding roller ; but, notwithstanding the different improvements that have been made, the grinding roller still holds the first rank. And why should it not ? An iron roller can be made as true as any straight-edge, and be set as parallel with the cylinder as any other system. Its simplicity and readiness for application are much in its favour, as the fixtures may remain ready set for operation at a moment's notice.

When the grinding is considered sufficient to bring the cards to a needle point, they should then be well brushed out, to clear away the dust. Take off the hooks, should there be any caused by grinding, so that the cotton may not adhere to the cards, but pass easily and smoothly through them, for it is the passing of the fibres through the wire of the cards that has the effect of disentangling the cotton and straightening the fibres. After the grinding and brushing out the next business will be the setting. In the first place, set the machine perfectly level, so that the main cylinder, doffer, licker-in, and rollers, may be parallel with each other, otherwise the ends or edges of the cylinder, doffer, and rollers, cannot be set near enough for producing first-rate carding.

While setting the cards, let the carding-engine revolve contrary to the usual way, so that the points will not damage each other if they should come in contact ; set the doffer, carding rollers, and top cards separately, till they touch the main cylinder from end to end equally ; then ease them off until they are but just clear of each other, which will be easily detected by the ear. The ear is the best gauge that can be used for the above purpose. In setting the



top cards the fore side, or the side next to the feeding rollers, should be raised up about  $\frac{3}{16}$  of an inch off the cylinder sheets, but the side next to the doffing cylinder should be set so close as just to allow the one to pass the other without touching. In setting the licker-in and clearer rollers, a thin piece of tin may be used as a gauge, or, what is still better, a piece of a doctor plate, such as calico printers use for clearing off the colouring matter from the copper printing rollers. Set the feeder in the same manner as the doffer, viz., while the carding-engine is going the backward way.

The feeding rollers for carding-engines were originally fluted iron rollers, till about the year 1830, when they were superseded by plain iron rollers covered with narrow filleting cards, which were considered at the time a decided improvement; but when both of these systems are taken into consideration and fairly examined they are found to be very defective. In neither case can proper carding be effected, either by the main cylinder or licker-in; for this reason, the cards cannot be brought sufficiently near the gripe of the rollers to have the effect of carding the cotton, because the distance between the gripe of the rollers and where the carding should take place is beyond the length of the fibre; consequently the cotton is taken in small quantities or bits that have not received that amount of combing or carding they ought to receive; in fact, the carding done by the main cylinder or licker-in, with the above-mentioned feeding rollers, may be set down as nothing, and the only use of the licker-in is simply to take the cotton from the feed rollers and deliver it to the main cylinder.

Another system of feeding carding-engines made its appearance about the year 1833—by whom invented I do not know, but I recollect seeing one about that time made by Messrs. Hibbert and Platt, of Oldham. At the present time, viz., 1864, they are very much approved of, but used for breaker-cards only; but if they were applied to finisher carding-engines they would be certain to give complete satisfaction; for the licker-in, in this case, is not a mere carrier of cotton, but a very effective carding-cylinder, and there is no doubt of its discharging more extraneous matter than all the other parts of the engine put together. The improved feeder consists of one roller, two inches in diameter, and a breast-plate with a raised curve or circular groove for the roller to work in, about one-fourth part of its circle; the front of the plate, or that part next to the licker-in, is planed to a straight-edge; the top edge of the plate is on a level with the centre of the feed roller, and about half an inch above the centre of the licker-in; the top edge of the breast-plate, over which the cotton has to pass,



is about the sixteenth of an inch, and a little rounded to prevent the cotton from being cut. The operation of carding is effected between the licker-in and the breast-plate (by setting the breast-plate as close as possible to the licker-in without touching), while the cotton is firmly held (within the length of the fibre) between the roller and the breast-plate ; and as the feed roller moves with a very slow motion the licker-in has the best effect possible, in respect to straightening the fibres and combing out the small shelly particles of the seeds and husks of the cotton, and lets them fall beneath.

## CARDING-ENGINE No. 1.

General particulars of a carding-engine suitable for yarn up to 20 hanks to the pound, consisting of main cylinder, doffer, six carding and six clearer rollers, licker-in, feed roller, drawing-box, plunger, and can-motion.

DIAMETER, WIDTH, AND REVOLUTIONS PER MINUTE OF THE FOLLOWING.

|                       | In. diam. | In. wide. | Revolutions per minute. |
|-----------------------|-----------|-----------|-------------------------|
| Main cylinder.....    | 48        | 49        | 160                     |
| Doffer .....          | 24        | 49        | 10·7143                 |
| Carding rollers ..... | 6         | 49        | 32                      |
| Clearer rollers ..... | 4         | 49        | 249                     |
| Licker-in .....       | 12        | 49        | 249                     |
| Feed roller.....      | 2         | 48        | 1·7857                  |

CARDS SUITABLE FOR THE ABOVE.

|                       | In. wide. | Counts. | Crowns. |
|-----------------------|-----------|---------|---------|
| Main cylinder .....   | 48        | 80's    | 9       |
| Doffer .....          | 49        | 90's    | 9       |
| Carding rollers ..... | 48        | 80's    | 9       |
| Clearer rollers ..... | 48        | 60's    | 7       |
| Licker-in .....       | 48        | 60's    | 7       |

SPUR WHEELS FROM MAIN CYLINDER TO DOFFER.

|                             | Teeth.     | Revolutions per minute. |
|-----------------------------|------------|-------------------------|
| Main cylinder wheel .....   | 42         | 160                     |
| Double carrier wheels ..... | 168 and 45 | 40                      |
| Doffer cylinder wheel ..... | 168        | 10·7143                 |

BEVEL WHEELS FROM DOFFER TO FEED ROLLER.

|                                  | Teeth. | Revolutions per minute. |
|----------------------------------|--------|-------------------------|
| Doffer and side shaft (each) ... | 50     | 10·7143                 |
| Side shaft feeder end.....       | 20     | 10·7143                 |
| Feed roller wheel .....          | 120    | 1·7857                  |



## DRAUGHT BETWEEN DOFFER AND FEED ROLLER.

Doffer cylinder .....  $24\text{in.} \times 120 = 2880$   
 Feed roller .....  $2\text{in.} \times 20 = \frac{40}{40} = 72$  draught.

## PULLEYS FROM MAIN CYLINDER TO LICKER-IN AND CLEARERS.

|                              | In. diam. | Revolutions<br>per minute. |
|------------------------------|-----------|----------------------------|
| Main cylinder pulley.....    | 14        | 160                        |
| Licker-in and clearers ..... | 9         | 249                        |
| Main cylinder pulley.....    | 32        | 160                        |
| Crank pulley .....           | 6         | 853                        |

## CHANGE WHEELS ON THE DOFFER AND CARDING ROLLERS.

|                            | In. diam. | Revolutions<br>per minute. |
|----------------------------|-----------|----------------------------|
| Doffer chain wheel.....    | 21        | 10·7143                    |
| Carding roller wheel ..... | 7         | 32                         |

## WHEELS FROM DOFFER TO BACK AND FRONT ROLLER OF DRAWING-BOX.

|                         | In. diam. | Revolutions<br>per minute. |
|-------------------------|-----------|----------------------------|
| Doffer wheel .....      | 168       | 10·7143                    |
| Doubler carrier .....   | 84 and 42 | 42·8572                    |
| Front shaft wheel ..... | 21        | 171·4288                   |

The front shaft wheel of 25 teeth, driving the back roller wheel of 25 teeth, will, of course, make the same revolutions, viz., 171·4288.

Then a wheel on the front shaft of 40 teeth, driving a 25 on the front roller,  $1\frac{1}{2}\text{in.}$  diameter, will give 274·286 revolutions of the front roller per minute.

The delivering rollers, three inches diameter, will make 137·143 revolutions per minute.

The draught in the drawing-box is 1 into 1·6, delivering a sliver of 66·6667 grains per yard, or 105yd. per lb.

Draught between doffer and feed roller, and draught in the drawing-box, will give the total draught of the carding-engine—thus:  $72 \times 1·6 = 115·2 \times 66·6667 = 7,680$  grains (add six per cent for loss in carding) will give the weight of one yard of feed, viz., 8,140 grains or 18oz. 11dwt. 1 grain.

The delivering rollers, 9·4248 inches in circumference, making 137·143 revolutions per minute, for 3,000 minutes per week of 50 hours, will give inches per week  $3,877,636 \div 36 = 107,712$  yards  $\div 105 = 1,025\text{lb.}$ , the produce of the carding-engine per week; add six per cent for loss in carding, and it will give a consumption of cotton of 1,086lb. per week.



## PRODUCE OF CHANGE WHEELS ON THE DOUBLE CARRIER PER WEEK.

|               |               |             |             |             |
|---------------|---------------|-------------|-------------|-------------|
| 45 = 1,025lb. | 44 = 1,002lb. | 43 = 979lb. | 42 = 956lb. | 41 = 934lb. |
| 40 = 911lb.   | 39 = 888lb.   | 38 = 865lb. | 37 = 842lb. | 36 = 820lb. |
| 35 = 797lb.   | 34 = 774lb.   | 33 = 751lb. | 32 = 730lb. | 31 = 706lb. |
| 30 = 683lb.   | 29 = 660lb.   | 28 = 637lb. | 27 = 615lb. | 26 = 592lb. |

## CARDING-ENGINE No. 2.

General particulars of a carding-engine suitable for yarn from 20 to 30 hanks in the pound, consisting of main cylinder, doffer, three carding rollers, three clearer rollers, eight top cards, licker-in, feed roller, drawing-box, plunger, and can-motion.

## DIAMETER WHEN BARE.

|                     | In. diam. | In. wide. | Revolutions per minute. |
|---------------------|-----------|-----------|-------------------------|
| Main cylinder.....  | 42        | 43        | 160                     |
| Doffer.....         | 21        | 43        | 8.256                   |
| Carding rollers ... | 6         | 43        | 25                      |
| Clearer rollers ... | 4         | 43        | 240                     |
| Licker-in .....     | 10        | 43        | 240                     |
| Feed roller .....   | 2         | 42        | 1.2384                  |

## CARDS SUITABLE FOR THE ABOVE.

|                       | In. wide. | Counts. | Crowns. |
|-----------------------|-----------|---------|---------|
| Main cylinder .....   | 42        | 90's    | 9       |
| Doffer .....          | 43        | 100's   | 9       |
| Carding rollers ..... | 42        | 90's    | 9       |
| Clearer rollers ..... | 42        | 60's    | 7       |
| Licker-in.....        | 42        | 60's    | 7       |
| 1st and 2nd top ..... | 42        | 50's    | 6       |
| 3rd and 4th top ..... | 42        | 60's    | 7       |
| 5th and 6th top ..... | 42        | 70's    | 8       |
| 7th and 8th top ..... | 42        | 80's    | 9       |

Before the tops are clothed they should be rounded across the face to the same curve as the main cylinder, and perfectly straight in their length, and numbered 1, 2, 3, &c., commencing at the licker-in.

## SPUR WHEELS FROM MAIN CYLINDER TO DOFFER.

|                              | Teeth.     | Revolutions per minute. |
|------------------------------|------------|-------------------------|
| Main cylinder wheel .....    | 27         | 160                     |
| Double carrier wheels .....  | 150 and 43 | 28.8                    |
| Doffer cylinder wheels ..... | 150        | 8.256                   |



## BEVEL WHEELS FROM DOFFER TO FEED ROLLER.

|                                    | Teeth.    | Revolutions<br>per minute. |
|------------------------------------|-----------|----------------------------|
| Doffer and side shaft wheels ..... | 50 .....  | 8.256                      |
| Side shaft feeder end wheel.....   | 18 .....  | 8.256                      |
| Feed roller wheel .....            | 120 ..... | 1.2384                     |

## DRAUGHT BETWEEN DOFFER AND FEED ROLLER.

|                       |                           |               |
|-----------------------|---------------------------|---------------|
| Doffer cylinder ..... | 21in. $\times$ 120 = 2526 | = 70 draught. |
| Feed roller .....     | 2in. $\times$ 18 = 36     |               |

WHEELS FROM THE DOFFER TO THE BACK AND FRONT ROLLERS OF THE  
DRAWING BOX.

|                              | Teeth.          | Revolutions<br>per minute. |
|------------------------------|-----------------|----------------------------|
| Doffer wheel .....           | 150 .....       | 8.256                      |
| Double carrier .....         | 76 and 37 ..... | 33.4702                    |
| Front shaft wheel .....      | 22 .....        | 115.62457                  |
| The other end of shaft ..... | 24 .....        | 115.62457                  |
| Back roller wheel .....      | 24 .....        | 115.62457                  |
| Front shaft wheel .....      | 36 .....        | 115.62457                  |
| Front roller wheel .....     | 24 .....        | 173.43685                  |

Will give a draught of 1.5 in the drawing-box,  $70 \times 1.5 = 105 =$  the total draught of the carding-engine.

The delivering roller of three inches diameter will make half the revolutions of the front roller of the drawing-box, viz., 86.7184.

120 yards of sliver delivered at the front of the carding-engine will weigh 11b., and one yard will weigh 58.3333 grains. Multiplied by the total draught of the engine, viz., 105 = 6,125 grains, to which add seven per cent for loss in carding, it will give 6553.75 grains, or 14oz. 17dwt. 20.75gr., the weight of one yard of feed.

## PULLEYS FROM MAIN CYLINDER TO LICKER-IN, CLEARERS, AND CRANK.

|                             | In. diam. | Revolutions<br>per minute. |
|-----------------------------|-----------|----------------------------|
| Main cylinder pulley .....  | 12 .....  | 160                        |
| Licker-in and clearers..... | 8 .....   | 240                        |

## FROM MAIN CYLINDER TO CRANK, WITH A TWO-INCH THROW.

|                            | In. Diam.  | Revolutions<br>per minute. |
|----------------------------|------------|----------------------------|
| Main cylinder pulley ..... | 20.5 ..... | 160                        |
| Crank pulley .....         | 6 .....    | 546                        |

The delivering rollers are 9.4248 inches in circumference, and making 86.7184 revolutions per minute, for 3,000 minutes per week of 50 hours, will give inches per week  $2,451,910 \div 36 = 68,108$



yards ÷ 120 = 567lb. per week ; add seven per cent for loss in carding, and it will give a consumption of cotton of 607lb. per week.

CHANGE WHEELS ON THE DOFFER AND CARDING ROLLERS.

|                            | In. Diam. | Revolutions<br>per minute. |
|----------------------------|-----------|----------------------------|
| Doffer chain wheels.....   | 21 .....  | 8·256                      |
| Carding roller wheel ..... | 7 .....   | 24·768                     |

PRODUCE OF CHANGE WHEELS ON THE DOUBLE CARRIER PER WEEK.

|             |               |             |               |             |
|-------------|---------------|-------------|---------------|-------------|
| 43 = 567lb. | 42 = 553·8lb. | 41 = 540lb. | 40 = 527·4lb. | 39 = 514lb. |
| 38 = 501lb. | 37 = 487lb.   | 36 = 474lb. | 35 = 461lb.   | 34 = 448lb. |
| 33 = 135lb. | 32 = 422lb.   | 31 = 408lb. | 30 = 395lb.   | 29 = 382lb. |

CARDING-ENGINES SUITABLE FOR 30's TO 50's.

Use No. 1 carding-engine as a breaker-card, with only delivering rollers, as the drawing-box is not necessary ; put up 40 slivers at the doubling machine, to form a lap-roller for the finisher carding-engine, 34 inches wide.

The weight of one yard from the doubling machine will be 4,240 grains, and a draught in the finisher card of 80 will give 50 grains per yard delivered by the finisher card, or 140 yards per pound ; six per cent has been allowed for loss in carding.

No. III.—FINISHER CARDING-ENGINE FOR 30's TO 50's.

General particulars of the carding-engine, consisting of main cylinder, doffer, licker-in, 14 top cards, feed-roller, delivering rollers, plunger, and can-motion.

|                     | In. diam. | In. wide. | Revolutions<br>per minute. |
|---------------------|-----------|-----------|----------------------------|
| Main cylinder ..... | 36 .....  | 37 .....  | 160                        |
| Doffer .....        | 18 .....  | 37 .....  | 9                          |
| Licker-in .....     | 9 .....   | 37 .....  | 249                        |
| 14 top cards.....   | — .....   | 37 .....  | —                          |

CARDS SUITABLE FOR THE ABOVE.

|                                | In. Wide. | Counts.     | Crowns. |
|--------------------------------|-----------|-------------|---------|
| Main cylinder .....            | 36 .....  | 100's ..... | 11      |
| Doffer .....                   | 37 .....  | 110's ..... | 12      |
| Licker-in .....                | 36 .....  | 60's .....  | 8       |
| 1st and 2nd top cards .....    | 36 .....  | 60's .....  | 7       |
| 3rd, 4th, and 5th top cards... | 36 .....  | 70's .....  | 8       |
| 6th, 7th, and 8th ,, ...       | 36 .....  | 80's .....  | 9       |
| 9th, 10th, and 11th ,, ...     | 36 .....  | 90's .....  | 10      |
| 12th, 13th, and 14th ,, ...    | 36 .....  | 100's ..... | 11      |



The tops to be rounded across the face, to the same circle as the main cylinder, and made perfectly straight in their length.

## SPUR WHEELS FROM MAIN CYLINDER TO DOFFER.

|                                       | Teeth.           | Revolutions<br>per minute. |
|---------------------------------------|------------------|----------------------------|
| Main cylinder wheel.....              | 28 .....         | 160                        |
| Double carrier wheels .....           | 126 and 32 ..... | 35.5555                    |
| Doffer cylinder wheel .....           | 126 .....        | 9                          |
| Delivering rollers, 3in. diameter ... | 21 .....         | 54                         |

## BEVEL WHEELS FROM DOFFER TO FEED ROLLER.

|                        | Teeth.    | Revolutions<br>per minute. |
|------------------------|-----------|----------------------------|
| Doffer wheel .....     | 45 .....  | 9                          |
| Side shaft wheel ..... | 60 .....  | 6.75                       |
| Side shaft wheel ..... | 18 .....  | 6.75                       |
| Feed roller wheel..... | 120 ..... | 1.0125                     |

## DRAUGHT BETWEEN DOFFER AND FEED ROLLER.

Doffer cylinder...18in. diameter  $\times 60 \times 120 = 129600$   
 Feed roller ..... 2in. ,,  $\times 45 \times 18 = \frac{1620}{129600} = 80$  draught

## PULLEYS FOR DRIVING LICKER-IN.

|                            | In. diam. | Revolutions<br>per minute. |
|----------------------------|-----------|----------------------------|
| Main cylinder pulley ..... | 14 .....  | 160                        |
| Licker-in pulley .....     | 9 .....   | 249                        |

## PULLEYS FOR DRIVING THE CRANK WITH A TWO-INCH THROW.

|                            | In. diam. | Revolutions<br>per minute. |
|----------------------------|-----------|----------------------------|
| Main cylinder pulley ..... | 19 .....  | 160                        |
| Crank pulley.....          | 6 .....   | 506                        |

## WHEELS FOR DRIVING DELIVERING ROLLERS THREE INCHES DIAMETER.

|                              | Teeth.    | Revolutions<br>per minute. |
|------------------------------|-----------|----------------------------|
| Doffer cylinder wheel .....  | 136 ..... | 9                          |
| Delivering roller wheel..... | 21 .....  | 54                         |

The delivering rollers are 9.4248 inches in circumference, and making 54 revolutions per minute, for 3,000 minutes per week of 50 hours, will give inches per week  $1,526,817 \div 36 = 42,420$  yards  $\div 140 = 303$ lb. produce per week.

PRODUCE OF CHANGE WHEELS ON THE END OF CYLINDER SHAFT,  
PER WEEK.

|             |             |             |             |
|-------------|-------------|-------------|-------------|
| 28 = 303lb. | 27 = 292lb. | 26 = 281lb. | 25 = 270lb. |
| 24 = 260lb. | 23 = 249lb. | 22 = 238lb. | 21 = 227lb. |
| 20 = 216lb. | 19 = 205lb. | 18 = 195lb. |             |



## CARDING-ENGINES SUITABLE FOR 50's TO 75's.

Use No. 2 carding-engine, as a breaker-card, with only the delivering rollers (the drawing-box not being necessary); put up 40 slivers at the doubling machine, to form a lap for the finisher carding-engine, 34 inches wide. One yard from the doubling machine will weigh 3,500 grains or half a pound, and with a draught of 83.1 will give 40 grains per yard, delivered by the finisher card, or 175 yards per pound; five per cent has been allowed for loss in carding.

## No. IV.—FINISHER CARDING-ENGINE FOR 50's. TO 75's.

General particulars of the carding-engine, consisting of main cylinder, doffer, licker-in, 14 top cards, feed roller, delivering rollers, plunger, and can-motion.

|                     | In. diam. | In. wide. | Revolutions<br>per minute. |
|---------------------|-----------|-----------|----------------------------|
| Main cylinder ..... | 36        | 37        | 150                        |
| Doffer .....        | 18        | 37        | 7.142                      |
| Licker-in .....     | 9         | 37        | 234                        |
| 14 top cards .....  | —         | 37        | —                          |

## CARDS SUITABLE FOR THE ABOVE.

|                             | In. Wide. | Counts. | Crowns. |
|-----------------------------|-----------|---------|---------|
| Main cylinder .....         | 36        | 100's   | 12      |
| Doffer .....                | 37        | 110's   | 13      |
| Licker-in .....             | 36        | 60's    | 8       |
| 1st and 2nd top cards ..... | 36        | 60's    | 8       |
| 3rd, 4th, and 5th top cards | 36        | 70's    | 8       |
| 6th, 7th, and 8th „         | 36        | 80's    | 9       |
| 9th, 10th, and 11th „       | 36        | 90's    | 10      |
| 12th, 13th, and 14th „      | 36        | 100's   | 11      |

The tops to be rounded across the face to the same circle as the main cylinder, and made perfectly straight in their length before being clothed.

## SPUR WHEELS FROM MAIN CYLINDER TO DOFFER.

|                                    | Teeth.     | Revolutions<br>per minute. |
|------------------------------------|------------|----------------------------|
| Main cylinder wheels .....         | 27         | 150                        |
| Double carrier wheels .....        | 126 and 28 | 32.142                     |
| Doffer cylinder wheel .....        | 126        | 7.142                      |
| Delivering rollers, 3in. diam..... | 21         | 42.852                     |

## BEVEL WHEELS FROM DOFFER TO FEED ROLLER.

|                        | Teeth. | Revolutions<br>per minute. |
|------------------------|--------|----------------------------|
| Doffer wheel.....      | 46     | 7.142                      |
| Side shaft wheel ..... | 60     | 4.4755                     |
| Side shaft wheel ..... | 17     | 4.4755                     |
| Feed roller wheel..... | 120    | 7.7566                     |



26 CARDING-ENGINES SUITABLE FOR 75's TO 150's.

DRAUGHT BETWEEN DOFFER AND FEED ROLLER.

Doffer cylinder...18in. diam.  $\times 60 \times 120 = 129600$   
Feed roller ..... 2     „      $\times 46 \times 17 = 1560$  = 83.1 draught.

PULLEYS FOR DRIVING LICKER-IN.

|                            | In. diam. | Revolutions<br>per minute. |
|----------------------------|-----------|----------------------------|
| Main cylinder pulley ..... | 14 .....  | 150                        |
| Licker-in pulley.....      | 9 .....   | 234                        |

PULLEYS FOR DRIVING THE CRANK WITH A TWO-INCH THROW.

|                           | In. diam. | Revolutions<br>per minute. |
|---------------------------|-----------|----------------------------|
| Main cylinder pulley..... | 16 .....  | 150                        |
| Crank pulley.....         | 6 .....   | 400                        |

WHEELS FOR DRIVING DELIVERING ROLLERS OF THREE INCHES DIAMETER.

|                               | Teeth.    | Revolutions<br>per minute. |
|-------------------------------|-----------|----------------------------|
| Doffer cylinder wheel .....   | 126 ..... | 7.142                      |
| Delivering roller wheel ..... | 21 .....  | 42.852                     |

The delivery rollers are 9.4248 inches in circumference, and making 42.852 revolutions per minute for 3,000 minutes per week of fifty hours, will give inches per week  $1,211,614 \div 36 = 33,656 \div 175 = 192\text{lb.}$  produce per week.

PRODUCE OF CHANGE WHEELS ON THE END OF CYLINDER SHAFT, PER WEEK.

|             |             |             |             |
|-------------|-------------|-------------|-------------|
| 28 = 200lb. | 27 = 192lb. | 26 = 185lb. | 25 = 178lb. |
| 24 = 171lb. | 23 = 164lb. | 22 = 156lb. | 21 = 149lb. |
| 20 = 142lb. | 19 = 139lb. | 18 = 128lb. |             |

CARDING-ENGINES SUITABLE FOR 75's TO 150's.

Use No. 2 carding-engine as a breaker-card, with delivering rollers (without drawing-box, as it is not necessary), put up 34 slivers at the doubling machine, to form a lap roller for the finisher carding-engine, 28 inches wide.

One yard from the doubling machine will weigh 2,720 grains, and with a draught of 80 in the finisher carding-engine, will give 33.333 grains per yard, delivered by the finisher card, or 210 yards per pound ; 5 per cent has been allowed for loss in carding.

No. V.—FINISHER CARDING-ENGINE SUITABLE FOR 75's TO 150's.

General particulars of the carding-engine, consisting of main cylinder, doffer, licker-in, 14 top cards, feed rollers, delivering rollers, plunger, and can-motion.

|                     | In. diam. | In. wide. | Revolutions<br>per minute. |
|---------------------|-----------|-----------|----------------------------|
| Main cylinder ..... | 36 .....  | 31 .....  | 140                        |
| Doffer.....         | 16 .....  | 31 .....  | 6.5722                     |
| Licker-in .....     | 9 .....   | 31 .....  | 218                        |



CARDS SUITABLE FOR THE ABOVE.

|                                   | In. wide. | Counts.     | Crowns. |
|-----------------------------------|-----------|-------------|---------|
| Main cylinder .....               | 30 .....  | 110's ..... | 13      |
| Doffer .....                      | 31 .....  | 120's ..... | 14      |
| Licker-in .....                   | 30 .....  | 60's .....  | 8       |
| 1st and 2nd top cards .....       | 30 .....  | 60's .....  | 8       |
| 3rd, 4th, and 5th top cards ..... | 30 .....  | 70's .....  | 9       |
| 6th, 7th, and 8th „ .....         | 30 .....  | 80's .....  | 10      |
| 9th, 10th, and 11th „ .....       | 30 .....  | 90's .....  | 11      |
| 12th, 13th, and 14th „ .....      | 30 .....  | 100's ..... | 12      |

The tops to be rounded across the face to the same circle as the main cylinder, and made perfectly straight in their length before being clothed.

SPUR WHEELS FROM THE MAIN CYLINDER TO THE DOFFER.

|                                      | Teeth.           | Revolutions per minute. |
|--------------------------------------|------------------|-------------------------|
| Main cylinder wheel .....            | 26 .....         | 140                     |
| Double carrier .....                 | 120 and 26 ..... | 30.333                  |
| Doffer cylinder .....                | 128 .....        | 6.5722                  |
| Delivering rollers, 3in. diameter... | 22 .....         | 35.8483                 |

BEVEL WHEELS FROM THE DOFFER TO THE FEED ROLLER.

|                    | Teeth.    | Revolutions per minute. |
|--------------------|-----------|-------------------------|
| Doffer wheel ..... | 45 .....  | 6.5722                  |
| Side shaft .....   | 60 .....  | 4.92915                 |
| Side shaft ... ..  | 16 .....  | 4.92915                 |
| Feed roller .....  | 120 ..... | 6.5722                  |

DRAUGHT BETWEEN THE DOFFER AND THE FEED ROLLER.

Doffer cylinder..16in.diameter × 60 × 120 = 115200  
Feed roller ..... 2in.diameter × 16 × 45 = 1440 = 80 draught.

PULLEYS FOR DRIVING THE LICKER-IN.

|                            | In. diam. | Revolutions per minute. |
|----------------------------|-----------|-------------------------|
| Main cylinder pulley ..... | 14 .....  | 140                     |
| Licker-in .....            | 9 .....   | 218                     |

PULLEYS FOR DRIVING THE CRANK WITH A TWO-INCH THROW.

|                            | In. diam. | Revolutions per minute. |
|----------------------------|-----------|-------------------------|
| Main cylinder pulley ..... | 14 .....  | 140                     |
| Crank .....                | 6 .....   | 327                     |

WHEELS FOR DRIVING DELIVERING ROLLERS OF THREE INCHES DIAMETER.

|                             | Teeth.    | Revolutions per minute. |
|-----------------------------|-----------|-------------------------|
| Doffer cylinder wheel ..... | 120 ..... | 6.5722                  |
| Delivering rollers .....    | 22 .....  | 35.8483                 |



The delivering rollers, 3in. diameter = 9.4248 in circumference, and making 35.8483 revolutions per minute, for 3,000 minutes per week of 50 hours, will give inches per week  $1,016,589 \div 36 = 28,238$  yards  $\div 210 = 134$ lb. produce per week.

PRODUCE OF THE CHANGE WHEELS ON THE END OF THE CYLINDER SHAFT.

|             |             |             |             |
|-------------|-------------|-------------|-------------|
| 26 = 134lb. | 25 = 129lb. | 24 = 124lb. | 23 = 119lb. |
| 22 = 114lb. | 21 = 109lb. | 20 = 103lb. | 19 = 98lb.  |
| 18 = 93lb.  | 17 = 88lb.  | 16 = 83lb.  | 15 = 77lb.  |

CARDING-ENGINES SUITABLE FOR 150's TO 250's.

Use No. 3 carding-engine as a breaker-card, put up 30 slivers at the doubling machine, to form a lap roller for the finisher carding-engine, 22 inches wide.

One yard from the doubling machine will weigh 1,500 grains, and with a draught of 85.33 in the finisher carding-engine will give 16.6666 grains per yard delivered by the finisher card, or 420 yards per pound ; 5 per cent has been allowed for loss in carding.

No. VI.—FINISHER CARDING-ENGINE SUITABLE FOR 150's TO 250's.

General particulars of the carding-engine, consisting of main cylinder, doffer, licker-in, 14 top cards, feed roller, and delivering rollers.

|                     | In. diam. |       | In. wide. |       | Revolutions<br>per minute. |
|---------------------|-----------|-------|-----------|-------|----------------------------|
| Main cylinder ..... | 36        | ..... | 25        | ..... | 120                        |
| Doffer.....         | 16        | ..... | 25        | ..... | 4.98                       |
| Licker-in .....     | 9         | ..... | 25        | ..... | 200                        |

CARDS SUITABLE FOR THE ABOVE.

|                               | In. wide. |       | Counts. |       | Crowns. |
|-------------------------------|-----------|-------|---------|-------|---------|
| Main cylinder.....            | 24        | ..... | 120's   | ..... | 14      |
| Doffer .....                  | 25        | ..... | 130's   | ..... | 5       |
| Licker-in.....                | 24        | ..... | 70's    | ..... | 9       |
| 1st and 2nd top card.....     | 24        | ..... | 80's    | ..... | 10      |
| 3rd, 4th, and 5th top card... | 24        | ..... | 90's    | ..... | 11      |
| 6th, 7th, and 8th top card... | 24        | ..... | 100's   | ..... | 12      |
| 9th, 10th, and 11th top card  | 24        | ..... | 110's   | ..... | 13      |
| 12th, 13th, and 14th top card | 24        | ..... | 120's   | ..... | 14      |

The tops to be rounded across the face to the same circle as the main cylinder, and made perfectly straight in their length before being clothed.



## SPUR WHEELS FROM THE MAIN CYLINDER TO THE DOFFER.

|                                      | Teeth.           | Revolutions<br>per minute. |
|--------------------------------------|------------------|----------------------------|
| Main cylinder wheel .....            | 26 .....         | 120                        |
| Double carrier .....                 | 120 and 23 ..... | 26                         |
| Doffer cylinder .....                | 120 .....        | 4.9833                     |
| Delivering rollers, 3-in. diam. .... | 22 .....         | 27.0907                    |

## BEVEL WHEELS FROM THE DOFFER TO THE FEED ROLLER.

|                    | Teeth.    | Revolutions<br>per minute. |
|--------------------|-----------|----------------------------|
| Doffer wheel ..... | 45 .....  | 4.9833                     |
| Side shaft .....   | 60 .....  | 3.7375                     |
| Side shaft .....   | 15 .....  | 3.7375                     |
| Feed roller.....   | 120 ..... | 4.672                      |

## DRAUGHT BETWEEN THE DOFFER AND THE FEED ROLLER.

Doffer cylinder...16in. diam.  $\times 60 \times 120 = \frac{115200}{1350} = 85.33$  draught.  
 Feed roller ..... 2in. diam.  $\times 15 \times 45 = \frac{1350}{1350}$

## PULLEYS FOR DRIVING THE LICKER-IN.

|                           | In. diam. | Revolutions<br>per minute. |
|---------------------------|-----------|----------------------------|
| Main cylinder pulley..... | 15 .....  | 120                        |
| Licker-in.....            | 9 .....   | 200                        |

## PULLEYS FOR DRIVING THE CRANK WITH A TWO-INCH THROW.

|                           | In. diam. | Revolutions<br>per minute. |
|---------------------------|-----------|----------------------------|
| Main cylinder pulley..... | 15 .....  | 120                        |
| Crank.....                | 7 .....   | 257                        |

## WHEELS FOR DRIVING THE DELIVERING ROLLER OF THREE INCHES DIAMETER.

|                             | Teeth.    | Revolutions<br>per minute. |
|-----------------------------|-----------|----------------------------|
| Doffer cylinder wheel ..... | 120 ..... | 4.9833                     |
| Delivering rollers .....    | 22 .....  | 27.1816                    |

The delivering rollers, 3in. diam. = 9.4248 in circumference, and making 27.1816 revolutions per minute, for 3,000 minutes per week of 50 hours, will give inches per week  $768,543 \div 36 = 21,348 \div 420 = 51$ lb. produce per week.

## PRODUCE OF THE CHANGE WHEELS ON THE END OF THE CYLINDER SHAFT.

|            |            |            |            |
|------------|------------|------------|------------|
| 26 = 51lb. | 25 = 49lb. | 24 = 47lb. | 23 = 45lb. |
| 22 = 43lb. | 21 = 41lb. | 20 = 39lb. | 19 = 37lb. |
| 18 = 35lb. | 17 = 33lb. | 16 = 31lb. | 15 = 29lb. |

## CARDING-ENGINES SUITABLE FOR 250's TO 350's.

Use No. 3 carding-engine, as a breaker-card, put up 20 slivers at the doubling machine, to form a lap roller for the finisher carder, 16 inches wide.

One yard from the doubling machine will weigh 1,000 grains, and with a draught of 96in. the finisher carding-engine will give



10 grains per yard delivered by the finisher-card, or 700 yards per pound ; 4·95 per cent has been allowed for loss in carding.

### No. VII.—FINISHER CARDING-ENGINE SUITABLE FOR 250's TO 350's.

General particulars of the carding-engine, consisting of main cylinder, doffer, licker-in, 14 top cards, feed rollers and delivering rollers.

|                    | In diam. | In. wide. | Revolutions<br>per minute. |
|--------------------|----------|-----------|----------------------------|
| Main cylinder..... | 36 ..... | 19 .....  | 100                        |
| Doffer.....        | 16 ..... | 19 .....  | 4·15                       |
| Licker-in .....    | 9 .....  | 19 .....  | 200                        |

#### CARDS SUITABLE FOR THE ABOVE.

|                               | In. wide. | Counts.     | Crowns· |
|-------------------------------|-----------|-------------|---------|
| Main cylinder.....            | 18 .....  | 130's ..... | 15      |
| Doffer.....                   | 19 .....  | 140's ..... | 16      |
| Licker-in.....                | 18 .....  | 80's .....  | 9       |
| 1st and 2nd top card.....     | 18 .....  | 80's .....  | 9       |
| 3rd, 4th, and 5th top card... | 18 .....  | 90's .....  | 11      |
| 6th, 7th, and 8th top card... | 18 .....  | 100's ..... | 12      |
| 9th, 10th, and 11th top card  | 18 .....  | 110's ..... | 13      |
| 12th, 13th, and 14th top card | 18 .....  | 120's ..... | 14      |

The tops to be rounded across the face to the same circle as the main cylinder, and made perfectly straight in their length before being clothed.

#### SPUR WHEELS FROM THE MAIN CYLINDER TO THE DOFFER.

|                                     | Teeth.           | Revolutions<br>per minute. |
|-------------------------------------|------------------|----------------------------|
| Main cylinder wheel .....           | 26 .....         | 100                        |
| Double carrier .....                | 120 and 23 ..... | 21·6666                    |
| Doffer cylinder .....               | 120 .....        | 4·15                       |
| Delivering rollers, 3in. diam. .... | 22 .....         | 22·6363                    |

#### BEVEL WHEELS FROM THE DOFFER TO THE FEED ROLLER.

|                        | Teeth.    | Revolutions<br>per minute. |
|------------------------|-----------|----------------------------|
| Doffer wheel .....     | 40 .....  | 4·15                       |
| Side shaft wheel ..... | 60 .....  | 2·7666                     |
| Side shaft „ .....     | 15 .....  | 2·7666                     |
| Feed roller „ .....    | 120 ..... | ·3458                      |

#### DRAUGHT BETWEEN THE DOFFER AND THE FEED ROLLER.

Doffer cylinder...16in. diam. × 60 × 120 = 115200  
Feedroller ..... 2in. diam. × 15 × 40 = 1200 = 96 draught.

#### PULLEYS FOR DRIVING THE LICKER-IN.

|                            | In. wide. | Revolutions<br>per minute. |
|----------------------------|-----------|----------------------------|
| Main cylinder pulley ..... | 15 .....  | 100                        |
| Licker-in .....            | 7½ .....  | 200                        |



PULLEYS FOR DRIVING THE CRANK WITH A TWO-INCH THROW.

|                           | In. wide. | Revolutions<br>per minute. |
|---------------------------|-----------|----------------------------|
| Main cylinder pulley..... | 15 .....  | 100                        |
| Crank.....                | 7 .....   | 214                        |

WHEELS FOR DRIVING THE DELIVERING ROLLERS THREE INCHES DIAMETER.

|                             | Teeth.    | Revolutions<br>per minute. |
|-----------------------------|-----------|----------------------------|
| Doffer cylinder wheel ..... | 120 ..... | 4.15                       |
| Delivering roller.....      | 22 .....  | 22.6363                    |

The delivering rollers, 3in. diam. = 9.4248 in circumference, and making 22.6363 revolutions per minute, for 3,000 minutes per week of 50 hours, will give inches per week  $640,027 \div 36 = 17,778$  yards  $\div 700 = 25$ lb. produce per week.

PRODUCE OF THE CHANGE WHEELS ON THE END OF THE CYLINDER SHAFT.

|            |            |            |            |
|------------|------------|------------|------------|
| 26 = 25lb. | 25 = 24lb. | 24 = 23lb. | 23 = 22lb. |
| 22 = 21lb. | 21 = 20lb. | 20 = 19lb. | 19 = 18lb. |
| 18 = 17lb. | 17 = 16lb. | 16 = 15lb. | 15 = 14lb. |

DRAWING-FRAMES.

Although the carding-engines have done all they can do towards straightening the fibres, there still remains much more to be done before the cotton is in a proper state for spinning into yarn. The card-slivers have to go through the process of doubling and drawing out again to something like their original size, and this process has to be repeated through three or four drawing heads, by putting together six or eight slivers at the back of the head, and delivering the same in one sliver at the front. The number of doublings should be regulated according to the quality of the cotton and the counts of yarn to be made from it. In the following Drawing-frame Tables the proper amount of doubling in the drawing-frame will be found suitable for all counts of yarn from 6 to 350 hanks in the pound.

Also the various draughts, practically arranged, the revolutions of the front rollers per minute, and the product per week given for one delivery. Doubling and drawing are the means made use of for straightening the fibres and equalising the sliver, slubbing, roving, &c.; or, in other words, to bring them as near as possible to perfect uniformity of substance as circumstances will admit for making a good thread. All drawing-frames should be provided with a stopping motion that is very sensitive and certain in its action, so that whenever the sliver comes to an end, it should be so sure and safe as to be almost an impossibility for the end to pass through the rollers without stopping the drawing-head. It is essentially necessary that all piecings should be made at the back of the rollers of the drawing-head, and never in front of



either drawing frames or carding-engines. By this it will be understood that a can should on no account contain a piecing. If the sliver comes to an end, however small the quantity, take the can away and put it through the next operation. The best method of piecing at the drawing and slubbing frames is to taper the ends and lay one on the other, just at the entrance to the rollers. The guides for conducting the slivers into the rollers should be arranged so as to keep the cotton moderately well together, but not so as to be crowded; yet the different strands that compose the sliver should not be discernable in front nor cover more than one-half of the boss of the roller.

When cotton is too much spread on the rollers it has a very injurious effect in making the web cloudy. This being the effect, what is the cause? The cause is simply this, the leather-rollers receive their motion second-hand from the surface of the cotton (which must from necessity be very irregular) instead of receiving it direct from the fluted rollers; on the contrary if the cotton be too much contracted it will have a similar effect by lifting the leather from the fluted rollers, so that either extremity becomes an evil. This is a matter of too much importance to be disregarded, for it is necessary that the top and bottom rollers should make the same surface speed, or bad work is a sure consequence. The weight applied at each end of the top rollers is from 16 to 18 pounds. Loose bosses for drawing-frame rollers are very much approved of, and likely to come into general use. Cleanliness is a very important condition in all the different departments of preparing for and spinning cotton yarn, and more particularly so at the drawing-frames; the rollers should be kept perfectly clean, and free from grease, otherwise they have a tendency to lick up the cotton, which is the principal cause of the rollers lapping, and is one of the greatest evils and the most annoying of anything in connection with the drawing-frame. As soon as the rollers show any indication to lapping they should be removed and replaced by new rollers or bosses, or such rollers or bosses that have received a coat of varnish. It is well to have a sufficient reserve of them to be in readiness.

#### VARNISH.

A good varnish for rollers may be made in the following manner: Put into a small stew-mug scraps of roller leather, till the mug is about half full (in a loose state); then fill up with water, and cover the mug with a plate to keep in the steam; let it simmer or stew for about twenty-four hours, or until the leather is dissolved; when cold it may be laid on with a soft paint-brush or otherwise. This varnish will dry in about half-an-hour.



## CANS.

Coarse card cans are about 40 inches deep and 10 inches diameter, say for yarn up to 20 hanks ; the card and drawing-frame cans from 20's upwards are generally 36 inches deep and 9 inches diameter. The cans at the last delivery of the drawing-frame may have to be constructed to suit the gauge of the slubbing-frame ; but in all cases let the cans be as large in diameter as there is convenient standing room for two rows of cans behind the slubbing-frame.

The sliver ought to be firmly pressed together, both in the conducting funnel and the delivering rollers, so as to make it more compact, that it may be better able to sustain its own weight without straining. It is very desirable to put as much cotton into the cans, without injury, as possible. There are two methods for accomplishing this. One method is the coiler and can-motion, the other is the plunger. Some of the most practical spinners give preference to the latter method, as the least objectionable ; in fact, it is a matter of some difficulty to discover any depreciation sustained by the use of the plunger. The length of the plunger is about 14 inches round on the top and two-thirds the diameter of the can, and weighs about 28 pounds. It may be used for pressing the drawing-frame cans for all counts of yarn where quantity is of any advantage. Even in the finer counts it may be used to a moderate extent without any injury. The cans should revolve slowly, so that the cotton may build up evenly. The coiler has nothing in its favour over the plunger except its beautiful neatness of appearance when the cans are full, and that beauty is deceptive so far as quality is concerned, for no sooner does the cotton begin to press against the top plate than the straining of the sliver begins, and increases with the pressure until the sliver begins to break. This breakage continues to be more frequent the longer the can remains. All this takes place without the least appearance of anything being wrong, for the sliver continues to go into the can as if nothing was the matter, and is laid as neatly in the can as if it were one continuous sliver and had not a break in it. There is no remedy for this evil—for evil it is, and so will remain as long as it is used for pressing the card and drawing-frame cans—for to remove the evil would be to destroy the intention of the coiler, viz., the putting of an extra quantity into the cans. For fine counts of yarn, say upwards of 150's, pressure is very rarely applied to either carding or drawing cans except what may be done by hand ; but generally it is strictly forbidden by the best spinners, as quality with them is of the first importance. Cans filled without pressure is quite sufficient for them.



## No I.—DRAWING-FRAME TABLE.

*Drawing-frames suitable for yarn of the following counts, viz.,  
from 6 to 14 hanks in the pound.*

| COUNTS OF YARN IN THE POUND. ...                  | 6               | 7-8             | 9-10            | 11-12           | 13-14           |
|---------------------------------------------------|-----------------|-----------------|-----------------|-----------------|-----------------|
| Card sliver in decimal hank .....                 | ·125            | ·125            | ·125            | ·125            | ·125            |
| Ends put up at the first head .....               | 6               | 6               | 6               | 6               | 6               |
| Back draught in the first head .....              | 1·6             | 1·6             | 1·6             | 1·6             | 1·6             |
| Middle draught in the first head ...              | 1·8             | 1·8             | 1·8             | 1·8             | 1·8             |
| Front draught in the first head .....             | 2·08            | 2·08            | 2·08            | 2·08            | 2·08            |
| Total draught in the first head .....             | 5·99            | 5·99            | 5·99            | 5·99            | 5·99            |
| Decimal hank at the first head .....              | ·125            | ·125            | ·125            | ·125            | ·125            |
| Ends put up at the second head.....               | 6               | 6               | 6               | 6               | 6               |
| Back draught in the second head ...               | 1·6             | 1·6             | 1·6             | 1·6             | 1·6             |
| Middle draught in the second head...              | 1·8             | 1·8             | 1·8             | 1·8             | 1·8             |
| Front draught in the second head...               | 2·08            | 2·08            | 2·08            | 2·08            | 2·08            |
| Total draught in the second head ...              | 5·99            | 5·99            | 5·99            | 5·99            | 5·99            |
| Decimal hank at the second head ...               | ·125            | ·125            | ·125            | ·125            | ·125            |
| Ends put up at the third head .....               | 6               | 6               | 6               | 6               | 6               |
| Back draught in the third head.....               | 1·6             | 1·6             | 1·6             | 1·6             | 1·6             |
| Middle draught in the third head ...              | 1·8             | 1·8             | 1·8             | 1·8             | 1·8             |
| Front draught in the third head ...               | 2·08            | 2·08            | 2·08            | 2·08            | 2·08            |
| Total draught in the third head.....              | 5·99            | 5·99            | 5·99            | 5·99            | 5·99            |
| Decimal hank at the third head.....               | ·125            | ·125            | ·125            | ·125            | ·125            |
| Diameter of the front rollers .....               | 1 $\frac{3}{8}$ | 1 $\frac{3}{8}$ | 1 $\frac{3}{8}$ | 1 $\frac{3}{8}$ | 1 $\frac{3}{8}$ |
| Circumference of the front rollers...             | 4·32            | 4·32            | 4·32            | 4·32            | 4·32            |
| Revolutions of front rollers per min.             | 330             | 330             | 330             | 330             | 330             |
| Produce per week of 45 hours in }<br>pounds ..... | 1018            | 1018            | 1018            | 1018            | 1018            |
| Spinning spindles supplied .....                  | 138             | 160             | 216             | 261             | 390             |



## No. II.—DRAWING-FRAME TABLE.

*Drawing-frames suitable for yarn of the following counts, viz.,  
from 15 to 20 hanks in the pound.*

| HANKS OF YARN IN THE POUND.....                   | 15-16           | 17              | 18              | 19              | 20              |
|---------------------------------------------------|-----------------|-----------------|-----------------|-----------------|-----------------|
| Card sliver in decimal hank .....                 | ·125            | ·125            | ·125            | ·125            | ·125            |
| Ends put up at the first head.....                | 6               | 6               | 6               | 6               | 6               |
| Back draught in the first head .....              | 1·6             | 1·6             | 1·6             | 1·6             | 1·6             |
| Middle draught in the first head ...              | 1·8             | 1·8             | 1·8             | 1·8             | 1·8             |
| Front draught in the first head .....             | 2·08            | 2·08            | 2·08            | 2·08            | 2·08            |
| Total draught in the first head .....             | 5·99            | 5·99            | 5·99            | 5·99            | 5·99            |
| Decimal hank in the first head .....              | ·125            | ·125            | ·125            | ·125            | ·125            |
| Ends put up at the second head.....               | 6               | 6               | 6               | 6               | 6               |
| Back draught in the second head ...               | 1·6             | 1·6             | 1·6             | 1·6             | 1·6             |
| Middle draught in the second head...              | 1·8             | 1·8             | 1·8             | 1·8             | 1·8             |
| Front draught in the second head ...              | 2·08            | 2·08            | 2·08            | 2·08            | 2·08            |
| Total draught in the second head ...              | 5·99            | 5·99            | 5·99            | 5·99            | 5·99            |
| Decimal hank at the second head ...               | ·125            | ·125            | ·125            | ·125            | ·125            |
| Ends put up at the third head .....               | 6               | 6               | 6               | 6               | 6               |
| Back draught in the third head .....              | 1·6             | 1·6             | 1·6             | 1·6             | 1·6             |
| Middle draught in the third head ...              | 1·8             | 1·8             | 1·8             | 1·8             | 1·8             |
| Front draught in the third head ...               | 2·08            | 2·08            | 2·08            | 2·08            | 2·08            |
| Total draught in the third head.....              | 5·99            | 5·99            | 5·99            | 5·99            | 5·99            |
| Decimal hank at the third head .....              | ·125            | ·125            | ·125            | ·125            | ·125            |
| Diameter of the front rollers .....               | 1 $\frac{3}{8}$ | 1 $\frac{3}{8}$ | 1 $\frac{3}{8}$ | 1 $\frac{3}{8}$ | 1 $\frac{3}{8}$ |
| Circumference of the front rollers ...            | 4·32            | 4·32            | 4·32            | 4·32            | 4·32            |
| Revolutions of front rollers per min.             | 330             | 330             | 330             | 330             | 330             |
| Produce per week of 45 hours in }<br>pounds ..... | 1018            | 1018            | 1018            | 1018            | 1018            |
| Spinning spindles supplied.....                   | 334             | 390             | 412             | 434             | 458             |



## No. III.—DRAWING-FRAME TABLE.

*Drawing-frames suitable for yarn of the following counts, viz.,  
from 22 to 30 hanks in the pound.*

| HANKS OF YARN IN THE POUND...                     | 22              | 24              | 26              | 28              | 30              |
|---------------------------------------------------|-----------------|-----------------|-----------------|-----------------|-----------------|
| Card sliver in decimal hank.....                  | ·125            | ·125            | ·125            | ·1428           | ·1428           |
| Ends put up at the first head.....                | 6               | 6               | 6               | 6               | 6               |
| Back draught in the first head.....               | 1·6             | 1·6             | 1·6             | 1·6             | 1·6             |
| Middle draught in the first head...               | 1·8             | 1·8             | 1·8             | 1·8             | 1·8             |
| Front draught in the first head ...               | 2·08            | 2·08            | 2·08            | 2·08            | 2·08            |
| Total draught in the first head.....              | 5·99            | 5·99            | 5·99            | 5·99            | 5·99            |
| Decimal hank at the first head ...                | ·125            | ·125            | ·125            | ·1428           | ·1428           |
| Ends put up at the second head...                 | 6               | 6               | 6               | 6               | 6               |
| Back draught in the second head                   | 1·6             | 1·6             | 1·6             | 1·6             | 1·6             |
| Middle draught in the second head                 | 1·8             | 1·8             | 1·8             | 1·8             | 1·8             |
| Front draught in the second head                  | 2·08            | 2·08            | 2·08            | 2·08            | 2·08            |
| Total draught in the second head                  | 5·99            | 5·99            | 5·99            | 5·99            | 5·99            |
| Decimal hank at the second head                   | ·125            | ·125            | ·125            | ·1428           | ·1428           |
| Ends put up at the third head ...                 | 6               | 6               | 6               | 6               | 6               |
| Back draught in the third head...                 | 1·6             | 1·6             | 1·6             | 1·6             | 1·6             |
| Middle draught in the third head                  | 1·8             | 1·8             | 1·8             | 1·8             | 1·8             |
| Front draught in the third head...                | 2·08            | 2·08            | 2·08            | 2·08            | 2·08            |
| Total draught in the third head...                | 5·99            | 5·99            | 5·99            | 5·99            | 5·99            |
| Decimal hank at the third head...                 | ·125            | ·125            | ·125            | ·1428           | ·1428           |
| Diameter of the front rollers .....               | 1 $\frac{3}{8}$ | 1 $\frac{3}{8}$ | 1 $\frac{3}{8}$ | 1 $\frac{3}{8}$ | 1 $\frac{3}{8}$ |
| Circumference of the front rollers                | 4·32            | 4·32            | 4·32            | 4·32            | 4·32            |
| Revolutions of front rollers per min.             | 330             | 330             | 330             | 330             | 330             |
| Produce per week of 48 hours in }<br>pounds ..... | 1084            | 1084            | 1084            | 948             | 948             |
| Spinning spindles supplied .....                  | 547             | 634             | 729             | 713             | 775             |



## No. IV.—DRAWING-FRAME TABLE.

*Drawing-frames suitable for yarn of the following counts, viz., from 32 to 40 hanks in the pound.*

| HANKS OF YARN IN THE POUND ...                     | 32              | 34              | 36              | 38              | 40              |
|----------------------------------------------------|-----------------|-----------------|-----------------|-----------------|-----------------|
| Card sliver in decimal hanks...                    | ·1666           | 1·666           | ·1666           | ·1666           | ·1666           |
| Ends put up at the first head...                   | 6               | 6               | 6               | 6               | 6               |
| Back draught in the first head                     | 1·6             | 1·6             | 1·6             | 1·6             | 1·6             |
| Middle draught in the first head                   | 1·7             | 1·8             | 1·8             | 1·8             | 1·8             |
| Front draught in the first head                    | 1·89            | 2·08            | 2·08            | 2·08            | 2·08            |
| Total draught in the first head                    | 5·142           | 5·99            | 5·99            | 5·99            | 5·99            |
| Decimal hank at the first head                     | ·1428           | ·1666           | ·1666           | ·1666           | ·1666           |
| Ends put up at the second head                     | 6               | 6               | 6               | 6               | 6               |
| Back draught in the second head                    | 1·6             | 1·6             | 1·6             | 1·6             | 1·6             |
| Middle draught in second head                      | 1·8             | 1·8             | 1·8             | 1·8             | 1·8             |
| Front draught in second head                       | 2·08            | 2·08            | 2·08            | 2·08            | 2·08            |
| Total draught in second head                       | 5·99            | 5·99            | 5·99            | 5·99            | 5·99            |
| Decimal hank at second head                        | ·1428           | ·1666           | ·1666           | ·1666           | ·1666           |
| Ends put up at the third head                      | 6               | 6               | 6               | 6               | 6               |
| Back draught in the third head                     | 1·6             | 1·6             | 1·6             | 1·6             | 1·6             |
| Middle draught in the third head                   | 1·8             | 1·8             | 1·8             | 1·8             | 1·8             |
| Front draught in the third head                    | 2·08            | 2·08            | 2·08            | 2·08            | 2·08            |
| Total draught in the third head                    | 5·99            | 5·99            | 5·99            | 5·99            | 5·99            |
| Decimal hank at the third head                     | ·1428           | ·1666           | ·1666           | ·1666           | ·1666           |
| Diameter of the front rollers...                   | 1 $\frac{3}{8}$ | 1 $\frac{3}{8}$ | 1 $\frac{3}{8}$ | 1 $\frac{3}{8}$ | 1 $\frac{3}{8}$ |
| Circumference of front rollers..                   | 4·32            | 4·32            | 4·32            | 4·32            | 4·32            |
| Revolutions of front rollers }<br>per minute ..... | 330             | 330             | 330             | 330             | 330             |
| Produce per week of 48 hours }<br>in pounds .....  | 948             | 814             | 814             | 814             | 814             |
| Spinning spindles supplied ..                      | 854             | 802             | 874             | 948             | 1024            |



## No. V.—DRAWING-FRAME TABLE.

*Drawing-frames suitable for yarn of the following counts, viz., from 42 to 50 hanks in the pound.*

| HANKS OF YARN IN THE POUND .....                  | 42             | 44             | 46             | 48             | 50             |
|---------------------------------------------------|----------------|----------------|----------------|----------------|----------------|
| Card sliver in decimal hank .....                 | ·1666          | ·1666          | ·1666          | ·1666          | ·1666          |
| Ends put up at the first head.....                | 8              | 8              | 8              | 8              | 8              |
| Back draught in the first head .....              | 1·8            | 1·8            | 1·8            | 1·8            | 1·8            |
| Middle draught in the first head ...              | 2              | 2              | 2              | 2              | 2              |
| Front draught in the first head .....             | 2·22           | 2·22           | 2·22           | 2·22           | 2·22           |
| Total draught in the first head .....             | 7·99           | 7·99           | 7·99           | 7·99           | 7·99           |
| Decimal hank at the first head .....              | ·1666          | ·1666          | ·1666          | ·1666          | ·1666          |
| Ends put up at the second head.....               | 6              | 6              | 8              | 8              | 8              |
| Back draught in the second head ...               | 1·6            | 1·6            | 1·8            | 1·8            | 1·8            |
| Middle draught in the second head...              | 1·8            | 1·8            | 2              | 2              | 2              |
| Front draught in the second head...               | 2·08           | 2·08           | 2·22           | 2·22           | 2·22           |
| Total draught in the second head ...              | 5·99           | 5·99           | 7·99           | 7·99           | 7·99           |
| Decimal hank at the second head ...               | ·1666          | ·1666          | ·1666          | ·1666          | ·1666          |
| Ends put up at the third head .....               | 6              | 6              | 6              | 6              | 6              |
| Back draught in the third head.....               | 1·6            | 1·6            | 1·6            | 1·6            | 1·6            |
| Middle draught in the third head ...              | 1·8            | 1·8            | 1·8            | 1·8            | 1·8            |
| Front draught in the third head ...               | 2·08           | 2·08           | 2·08           | 2·08           | 2·08           |
| Total draught in the third head.....              | 5·99           | 5·99           | 5·99           | 5·99           | 5·99           |
| Decimal hank at the third head.....               | ·1666          | ·1666          | ·1666          | ·1666          | ·1666          |
| Diameter of the front rollers .....               | $1\frac{3}{8}$ | $1\frac{3}{8}$ | $1\frac{3}{8}$ | $1\frac{3}{8}$ | $1\frac{3}{8}$ |
| Circumference of the front rollers ...            | 4·32           | 4·32           | 4·32           | 4·32           | 4·32           |
| Revolutions of front rollers per minute           | 330            | 330            | 330            | 330            | 330            |
| Produce per week of 48 hours in }<br>pounds ..... | 813            | 813            | 813            | 813            | 813            |
| Spinning spindles supplied .....                  | 1096           | 1175           | 1257           | 1339           | 1423           |



## No. VI.—DRAWING-FRAME TABLE.

*Drawing-frames suitable for yarn of the following counts, viz., from 55 to 75 hanks in the pound.*

| HANKS OF YARN IN THE POUND.....                   | 55              | 60              | 65              | 70              | 75              |
|---------------------------------------------------|-----------------|-----------------|-----------------|-----------------|-----------------|
| Card sliver in decimal hank .....                 | ·2083           | ·2083           | ·2083           | ·2083           | ·2083           |
| Ends put up at the first head.....                | 8               | 8               | 8               | 8               | 8               |
| Back draught in the first head .....              | 1·8             | 1·8             | 1·8             | 1·8             | 1·8             |
| Middle draught in the first head ...              | 2               | 2               | 2               | 2               | 2               |
| Front draught in the first head .....             | 2·22            | 2·22            | 2·22            | 2·22            | 2·22            |
| Total draught in the first head .....             | 7·99            | 7·99            | 7·99            | 7·99            | 7·99            |
| Decimal hank at the first head .....              | ·2083           | ·2083           | ·2083           | ·2083           | ·2083           |
| Ends put up at the second head.....               | 8               | 8               | 8               | 8               | 8               |
| Back draught in the second head ...               | 1·8             | 1·8             | 1·8             | 1·8             | 1·8             |
| Middle draught in the second head...              | 2               | 2               | 2               | 2               | 2               |
| Front draught in the second head ...              | 2·22            | 2·22            | 2·22            | 2·22            | 2·22            |
| Total draught in the second head ...              | 7·99            | 7·99            | 7·99            | 7·99            | 7·99            |
| Decimal hank at the second head ...               | ·2083           | ·2083           | ·2083           | ·2083           | ·2083           |
| Ends put up at the third head .....               | 8               | 8               | 8               | 8               | 8               |
| Back draught in the third head .....              | 1·8             | 1·8             | 1·8             | 1·8             | 1·8             |
| Middle draught in the third head ...              | 2               | 2               | 2               | 2               | 2               |
| Front draught in the third head ...               | 2·22            | 2·22            | 2·22            | 2·22            | 2·22            |
| Total draught in the third head.....              | 7·99            | 7·99            | 7·99            | 7·99            | 7·99            |
| Decimal hank in the third head.....               | ·2083           | ·2083           | ·2083           | ·2083           | ·2083           |
| Diameter of the front rollers .....               | 1 $\frac{3}{8}$ | 1 $\frac{3}{8}$ | 1 $\frac{3}{8}$ | 1 $\frac{3}{8}$ | 1 $\frac{3}{8}$ |
| Circumference of the front rollers ...            | 4·32            | 4·32            | 4·32            | 4·32            | 4·32            |
| Revolutions of front rollers per minute           | 300             | 300             | 300             | 300             | 300             |
| Produce per week of 48 hours in }<br>pounds ..... | 592             | 592             | 592             | 592             | 592             |
| Spinning spindles supplied .....                  | 1192            | 1362            | 1536            | 1716            | 1904            |



## No. VII.—DRAWING-FRAME TABLE.

*Drawing-frames suitable for yarn of the following counts, viz.,  
from 80 to 100 hanks in the pound.*

| HANKS OF YARN IN THE POUND .....                 | 80              | 85              | 90              | 95              | 100             |
|--------------------------------------------------|-----------------|-----------------|-----------------|-----------------|-----------------|
| Card sliver in decimal hank .....                | ·25             | ·25             | ·25             | ·25             | ·25             |
| Ends put up at the first head .....              | 6               | 6               | 6               | 6               | 6               |
| Back draught in the first head .....             | 1·6             | 1·6             | 1·6             | 1·6             | 1·6             |
| Middle draught in the first head ...             | 1·8             | 1·8             | 1·8             | 1·8             | 1·8             |
| Front draught in the first head .....            | 2·08            | 2·08            | 2·08            | 2·08            | 2·08            |
| Total draught in the first head .....            | 5·99            | 5·99            | 5·99            | 5·99            | 5·99            |
| Decimal hank at the first head .....             | ·25             | ·25             | ·25             | ·25             | ·25             |
| Ends put up at the second head ...               | 6               | 6               | 6               | 6               | 6               |
| Back draught in the second head ...              | 1·6             | 1·6             | 1·6             | 1·6             | 1·6             |
| Middle draught in the second head...             | 1·8             | 1·8             | 1·8             | 1·8             | 1·8             |
| Front draught in the second head...              | 2·08            | 2·08            | 2·08            | 2·08            | 2·08            |
| Total draught in the second head ...             | 5·99            | 5·99            | 5·99            | 5·99            | 5·99            |
| Decimal hank at the second head ...              | ·25             | ·25             | ·25             | ·25             | ·25             |
| Ends put up at the third head .....              | 6               | 6               | 6               | 6               | 6               |
| Back draught in the third head.....              | 1·6             | 1·6             | 1·6             | 1·6             | 1·6             |
| Middle draught in the third head ...             | 1·8             | 1·8             | 1·8             | 1·8             | 1·8             |
| Front draught in the third head ...              | 2·08            | 2·08            | 2·08            | 2·08            | 2·08            |
| Total draught in the third head.....             | 5·99            | 5·99            | 5·99            | 5·99            | 5·99            |
| Decimal hank at the third head.....              | ·25             | ·25             | ·25             | ·25             | ·25             |
| Ends put up at the fourth head.....              | 6               | 6               | 6               | 6               | 6               |
| Back draught in the fourth head ...              | 1·6             | 1·6             | 1·6             | 1·6             | 1·6             |
| Middle draught in the fourth head...             | 1·8             | 1·8             | 1·8             | 1·8             | 1·8             |
| Front draught in the fourth head ...             | 2·08            | 2·08            | 2·08            | 2·08            | 2·08            |
| Total draught in the fourth head ...             | 5·99            | 5·99            | 5·99            | 5·99            | 5·99            |
| Decimal hank at the fourth head ...              | ·25             | ·25             | ·25             | ·25             | ·25             |
| Diameter of the front rollers .....              | 1 $\frac{3}{8}$ | 1 $\frac{3}{8}$ | 1 $\frac{3}{8}$ | 1 $\frac{3}{8}$ | 1 $\frac{3}{8}$ |
| Circumference of the front rollers ...           | 4·32            | 4·32            | 4·32            | 4·32            | 4·32            |
| Revolutions of front rollers per min.            | 300             | 300             | 300             | 300             | 300             |
| Produce per week of 48 hours in }<br>pounds..... | 494             | 494             | 494             | 494             | 494             |
| Spinning spindles supplied.....                  | 1855            | 1944            | 2118            | 2266            | 2449            |



## No. VIII.—DRAWING-FRAME TABLE.

*Drawing-frames suitable for yarn of the following counts, viz.,  
from 110 to 150 hanks in the pound.*

| HANKS OF YARN IN THE POUND. ....                 | 110             | 120             | 130             | 140             | 150             |
|--------------------------------------------------|-----------------|-----------------|-----------------|-----------------|-----------------|
| Card sliver in decimal hank .....                | ·25             | ·25             | ·25             | ·25             | ·25             |
| Ends put up at the first head .....              | 6               | 6               | 6               | 6               | 6               |
| Back draught in the first head .....             | ·6              | 1·6             | 1·6             | 1·6             | 1·6             |
| Middle draught in the first head ...             | 1·8             | 1·8             | 1·8             | 1·8             | 1·8             |
| Front draught in the first head .....            | 2·08            | 2·08            | 2·08            | 2·08            | 2·08            |
| Total draught in the first head .....            | 5·99            | 5·99            | 5·99            | 5·99            | 5·99            |
| Decimal hank at the first head .....             | ·25             | ·25             | ·25             | ·25             | ·25             |
| Ends put up at the second head ...               | 6               | 6               | 6               | 6               | 6               |
| Back draught in the second head ...              | 1·6             | 1·6             | 1·6             | 1·6             | 1·6             |
| Middle draught in the second head...             | 1·8             | 1·8             | 1·8             | 1·8             | 1·8             |
| Front draught in the second head ...             | 2·08            | 2·08            | 2·08            | 2·08            | 2·08            |
| Total draught in the second head ...             | 5·99            | 5·99            | 5·99            | 5·99            | 5·99            |
| Decimal hank at the second head ...              | ·25             | ·25             | ·25             | ·25             | ·25             |
| Ends put up at the third head .....              | 6               | 6               | 6               | 6               | 6               |
| Back draught in the third head.....              | 1·6             | 1·6             | 1·6             | 1·6             | 1·6             |
| Middle draught in the third head ...             | 1·8             | 1·8             | 1·8             | 1·8             | 1·8             |
| Front draught in the third head ...              | 2·08            | 2·08            | 2·08            | 2·08            | 2·08            |
| Total draught in the third head.....             | 5·99            | 5·99            | 5·99            | 5·99            | 5·99            |
| Decimal hank at the third head.....              | ·25             | ·25             | ·25             | ·25             | ·25             |
| Ends put up at the fourth head.....              | 6               | 6               | 6               | 6               | 6               |
| Back draught in the fourth head ...              | 1·6             | 1·6             | 1·6             | 1·6             | 1·6             |
| Middle draught in the fourth head...             | 1·8             | 1·8             | 1·8             | 1·8             | 1·8             |
| Front draught in the fourth head ...             | 2·08            | 2·08            | 2·08            | 2·08            | 2·08            |
| Total draught in the fourth head ...             | 5·99            | 5·99            | 5·99            | 5·99            | 5·99            |
| Decimal hank at the fourth head ...              | ·25             | ·25             | ·25             | ·25             | ·25             |
| Diameter of the front rollers .....              | 1 $\frac{3}{8}$ | 1 $\frac{3}{8}$ | 1 $\frac{3}{8}$ | 1 $\frac{3}{8}$ | 1 $\frac{3}{8}$ |
| Circumference of the front rollers ...           | 4·32            | 4·32            | 4·32            | 4·32            | 4·32            |
| Revolutions of front rollers per min.            | 250             | 250             | 250             | 250             | 250             |
| Produce per week of 48 hours in }<br>pounds..... | 410             | 410             | 410             | 410             | 410             |
| Spinning spindles supplied.....                  | 2342            | 2669            | 3012            | 3366            | 3734            |



## No. IX.—DRAWING-FRAME TABLE.

*Drawing-frames suitable for yarn of the following counts, viz.,  
from 160 to 200 hanks in the pound.*

| HANKS OF YARN IN THE POUND .....                 | 160            | 170            | 180            | 190            | 200            |
|--------------------------------------------------|----------------|----------------|----------------|----------------|----------------|
| Card sliver in decimal hank.....                 | .5             | .5             | .5             | .5             | .5             |
| Ends put up at the first head.....               | 8              | 8              | 8              | 8              | 8              |
| Back draught in the first head.....              | 1.8            | 1.8            | 1.8            | 1.8            | 1.8            |
| Middle draught in the first head.....            | 1.9            | 1.9            | 2              | 2              | 2              |
| Front draught in the first head.....             | 2.04           | 2.04           | 2.22           | 2.22           | 2.22           |
| Total draught in the first head.....             | 6.97           | 6.97           | 7.99           | 7.99           | 7.99           |
| Decimal hank at the first head.....              | .4375          | .4375          | .5             | .5             | .5             |
| Ends put up at the second head.....              | 8              | 8              | 8              | 8              | 8              |
| Back draught in the second head....              | 1.8            | 1.8            | 1.8            | 1.8            | 1.8            |
| Middle draught in the second head..              | 2              | 2              | 2              | 2              | 2              |
| Front draught in the second head ...             | 2.22           | 2.22           | 2.22           | 2.22           | 2.22           |
| Total draught in the second head....             | 7.99           | 7.99           | 7.99           | 7.99           | 7.99           |
| Decimal hank at the second head....              | .4375          | .4375          | .5             | .5             | .5             |
| Ends put up at the third head.....               | 8              | 8              | 8              | 8              | 8              |
| Back draught in the third head.....              | 1.8            | 1.8            | 1.8            | 1.8            | 1.8            |
| Middle draught in the third head ...             | 2              | 2              | 2              | 2              | 2              |
| Front draught in the third head ....             | 2.22           | 2.22           | 2.22           | 2.22           | 2.22           |
| Total draught in the third head.....             | 7.99           | 7.99           | 7.99           | 7.99           | 7.99           |
| Decimal hank at the third head.....              | .4375          | .4375          | .5             | .5             | .5             |
| Ends put up at the fourth head.....              | 8              | 8              | 8              | 8              | 8              |
| Back draught in the fourth head....              | 1.8            | 1.8            | 1.8            | 1.8            | 1.8            |
| Middle draught in the fourth head...             | 2              | 2              | 2              | 2              | 2              |
| Front draught in the fourth head....             | 2.22           | 2.22           | 2.22           | 2.22           | 2.22           |
| Total draught in the fourth head....             | 7.99           | 7.99           | 7.99           | 7.99           | 7.99           |
| Decimal hank at the fourth head....              | .4375          | .4375          | .5             | .5             | .5             |
| Diameter of the front rollers .....              | $1\frac{3}{8}$ | $1\frac{3}{8}$ | $1\frac{3}{8}$ | $1\frac{3}{8}$ | $1\frac{3}{8}$ |
| Circumference of the front rollers....           | 4.32           | 4.32           | 4.32           | 4.32           | 4.32           |
| Revolutions of front rollers per minute          | 250            | 250            | 250            | 250            | 250            |
| Produce per week of 48 hours in }<br>pounds..... | 235            | 235            | 205            | 205            | 205            |
| Spinning spindles supplied.....                  | 2355           | 2579           | 2452           | 2659           | 3015           |



## No. X.—DRAWING-FRAME TABLE.

*Drawing-frames suitable for yarn of the following counts, viz.,  
from 210 to 250 hanks in the pound.*

| HANKS OF YARN IN THE POUND.....                  | 210             | 220             | 230             | 240             | 250             |
|--------------------------------------------------|-----------------|-----------------|-----------------|-----------------|-----------------|
| Card sliver in decimal hank.....                 | ·5              | ·5              | ·5              | ·5              | ·5              |
| Ends put up at the first head.....               | 8               | 8               | 8               | 8               | 8               |
| Back draught in the first head.....              | 1·8             | 1·8             | 1·9             | 2               | 2               |
| Middle draught in the first head.....            | 2               | 2               | 2               | 2·17            | 2·17            |
| Front draught in the first head .....            | 2·22            | 2·22            | 2·36            | 2·3             | 2·3             |
| Total draught in the first head .....            | 7·99            | 7·99            | 8·96            | 9·98            | 9·98            |
| Decimal hank at the first head .....             | ·5              | ·5              | ·5625           | ·625            | ·625            |
| Ends put up at the second head.....              | 8               | 8               | 8               | 8               | 8               |
| Back draught in the second head....              | 1·8             | 1·8             | 1·8             | 1·8             | 1·8             |
| Middle draught in the second head..              | 2               | 2               | 2               | 2               | 2               |
| Front draught in the second head...              | 2·22            | 2·22            | 2·22            | 2·22            | 2·22            |
| Total draught in the second head ...             | 7·99            | 7·99            | 7·99            | 7·99            | 7·99            |
| Decimal hank at the second head ...              | ·5              | ·5              | ·5625           | ·625            | ·625            |
| Ends put up at the third head .....              | 8               | 8               | 8               | 8               | 8               |
| Back draught in the third head.....              | 1·8             | 1·8             | 1·8             | 1·8             | 1·8             |
| Middle draught in the third head ...             | 2               | 2               | 2               | 2               | 2               |
| Front draught in the third head.....             | 2·22            | 2·22            | 2·22            | 2·22            | 2·22            |
| Total draught in the third head.....             | 7·99            | 7·99            | 7·99            | 7·99            | 7·99            |
| Decimal hank at the third head.....              | ·5              | ·5              | ·5625           | ·625            | ·625            |
| Ends put up at the fourth head.....              | 8               | 8               | 8               | 8               | 8               |
| Back draught in the fourth head.....             | 1·8             | 1·8             | 1·8             | 1·8             | 1·8             |
| Middle draught in the fourth head...             | 2               | 2               | 2               | 2               | 2               |
| Front draught in the fourth head ...             | 2·22            | 2·22            | 2·22            | 2·22            | 2·22            |
| Total draught in the fourth head ...             | 7·99            | 7·99            | 7·99            | 7·99            | 7·99            |
| Decimal hank at the fourth head....              | ·5              | ·5              | ·5625           | ·625            | ·625            |
| Diameter of the front roller .....               | 1 $\frac{3}{8}$ | 1 $\frac{3}{8}$ | 1 $\frac{3}{8}$ | 1 $\frac{3}{8}$ | 1 $\frac{3}{8}$ |
| Circumference of the front roller.....           | 4·32            | 4·32            | 4·32            | 4·32            | 4·32            |
| Revolutions of front rollers per minute          | 200             | 200             | 200             | 200             | 200             |
| Produce per week of 48 hours in }<br>pounds..... | 164             | 164             | 146             | 131·5           | 131·5           |
| Spinning spindles supplied.....                  | 2472            | 2650            | 2522            | 2422            | 2544            |



## No. XI.—DRAWING-FRAME TABLE.

*Drawing-frames suitable for yarn of the following counts, viz.,  
from 260 to 300 hanks in the pound.*

| HANKS OF YARN IN THE POUND .....                  | 260             | 270             | 280             | 290             | 300             |
|---------------------------------------------------|-----------------|-----------------|-----------------|-----------------|-----------------|
| Card sliver in decimal hank .....                 | ·8333           | ·8333           | ·8333           | ·8333           | ·8333           |
| Ends put up at the first head .....               | 8               | 8               | 8               | 8               | 8               |
| Back draught in the first head .....              | 1·6             | 1·6             | 1·7             | 1·7             | 1·7             |
| Middle draught in the first head ...              | 1·8             | 1·8             | 1·9             | 1·9             | 1·9             |
| Front draught in the first head .....             | 2·08            | 2·08            | 2·04            | 2·04            | 2·04            |
| Total draught in the first head .....             | 5·99            | 5·99            | 6·60            | 6·60            | 6·60            |
| Decimal hank at the first head .....              | ·625            | ·625            | ·6875           | ·6875           | ·6875           |
| Ends put up at the second head ...                | 8               | 8               | 8               | 8               | 8               |
| Back draught in the second head ...               | 1·8             | 1·8             | 1·8             | 1·8             | 1·8             |
| Middle draught in the second head..               | 2               | 2               | 2               | 2               | 2               |
| Front draught in the second head ...              | 2·22            | 2·22            | 2·22            | 2·22            | 2·22            |
| Total draught in the second head ...              | 7·99            | 7·99            | 7·99            | 7·99            | 7·99            |
| Decimal hank at the second head ...               | ·625            | ·625            | ·6875           | ·6875           | ·6875           |
| Ends put up at the third head .....               | 8               | 8               | 8               | 8               | 8               |
| Back draught in the third head.....               | 1·8             | 1·8             | 1·8             | 1·8             | 1·8             |
| Middle draught in the third head ...              | 2               | 2               | 2               | 2               | 2               |
| Front draught in the third head ...               | 2·22            | 2·22            | 2·22            | 2·22            | 2·22            |
| Total draught in the third head.....              | 7·99            | 7·99            | 7·99            | 7·99            | 7·99            |
| Decimal hank at the third head.....               | ·625            | ·625            | ·6875           | ·6875           | ·6875           |
| Ends put up at the fourth head.....               | 8               | 8               | 8               | 8               | 8               |
| Back draught in the fourth head ...               | 1·8             | 1·8             | 1·8             | 1·8             | 1·8             |
| Middle draught in the fourth head...              | 2               | 2               | 2               | 2               | 2               |
| Front draught in the fourth head ...              | 2·22            | 2·22            | 2·22            | 2·22            | 2·22            |
| Total draught in the fourth head ...              | 7·99            | 7·99            | 7·99            | 7·99            | 7·99            |
| Decimal hank at the fourth head ...               | ·625            | ·625            | ·6875           | ·6875           | ·6875           |
| Diameter of the front roller .....                | 1 $\frac{3}{8}$ | 1 $\frac{3}{8}$ | 1 $\frac{3}{8}$ | 1 $\frac{3}{8}$ | 1 $\frac{3}{8}$ |
| Circumference of the front roller ...             | 4·32            | 4·32            | 4·32            | 4·32            | 4·32            |
| Revolutions of front rollers per min.             | 150             | 150             | 150             | 150             | 150             |
| Produce per week of 48 hours in }<br>pounds ..... | 99              | 99              | 90              | 90              | 90              |
| Spinning spindles supplied.....                   | 2056            | 2179            | 2084            | 2200            | 2362            |



## No. XII.—DRAWING-FRAME TABLE.

*Drawing-frames suitable for yarn of the following counts, viz.,  
from 310 to 350 hanks in the pound.*

| HANKS OF YARN IN THE POUND.....                   | 310             | 320             | 330             | 340             | 350             |
|---------------------------------------------------|-----------------|-----------------|-----------------|-----------------|-----------------|
| Card sliver in decimal hank .....                 | ·8333           | ·8333           | ·8333           | ·8333           | ·8333           |
| Ends put up at the first head .....               | 8               | 8               | 8               | 8               | 8               |
| Back draught in the first head .....              | 1·7             | 1·7             | 1·8             | 1·8             | 1·8             |
| Middle draught in the first head ...              | 1·9             | 1·9             | 1·9             | 1·9             | 2               |
| Front draught in the first head .....             | 2·04            | 2·04            | 2·1             | 2·1             | 2·16            |
| Total draught in the first head .....             | 6·60            | 6·60            | 7·18            | 7·18            | 7·77            |
| Decimal hank at the first head .....              | ·6875           | ·6875           | ·75             | ·75             | ·8125           |
| Ends put up at the second head ...                | 8               | 8               | 8               | 8               | 8               |
| Back draught in the second head ...               | 1·8             | 1·8             | 1·8             | 1·8             | 1·8             |
| Middle draught in the second head...              | 2               | 2               | 2               | 2               | 2               |
| Front draught in the second head ...              | 2·22            | 2·22            | 2·22            | 2·22            | 2·22            |
| Total draught in the second head ...              | 7·99            | 7·99            | 7·99            | 7·99            | 7·99            |
| Decimal hank at the second head ...               | ·6875           | ·6875           | ·75             | ·75             | ·8125           |
| Ends put up at the third head .....               | 8               | 8               | 8               | 8               | 8               |
| Back draught in the third head.....               | 1·8             | 1·8             | 1·8             | 1·8             | 1·8             |
| Middle draught in the third head ...              | 2               | 2               | 2               | 2               | 2               |
| Front draught in the third head ...               | 2·22            | 2·22            | 2·22            | 2·22            | 2·22            |
| Total draught in the third head.....              | 7·99            | 7·99            | 7·99            | 7·99            | 7·99            |
| Decimal hank at the third head.....               | ·6875           | ·6875           | ·75             | ·75             | ·8125           |
| Ends put up at the fourth head.....               | 8               | 8               | 8               | 8               | 8               |
| Back draught in the fourth head ...               | 1·8             | 1·8             | 1·8             | 1·8             | 1·8             |
| Middle draught in the fourth head...              | 2               | 2               | 2               | 2               | 2               |
| Front draught in the fourth head ...              | 2·22            | 2·22            | 2·22            | 2·22            | 2·22            |
| Total draught in the fourth head ...              | 7·99            | 7·99            | 7·99            | 7·99            | 7·99            |
| Decimal hank at the fourth head ...               | ·6875           | ·6875           | ·75             | ·75             | ·8125           |
| Diameter of the front roller .....                | 1 $\frac{3}{8}$ | 1 $\frac{3}{8}$ | 1 $\frac{3}{8}$ | 1 $\frac{3}{8}$ | 1 $\frac{3}{8}$ |
| Circumference of the front roller ...             | 4·32            | 4·32            | 4·32            | 4·32            | 4·32            |
| Revolutions of front rollers per minute           | 150             | 150             | 150             | 150             | 150             |
| Produce per week of 48 hours in }<br>pounds ..... | 90              | 90              | 82              | 82              | 76              |
| Spinning spindles supplied .....                  | 2432            | 2552            | 2434            | 2546            | 2464            |



The following table shows the decimal hank of the various slivers represented (in carding and drawing) reduced into yards per lb., and the weight of six yards is given in pennyweights and grains:—

T A B L E.

| Decimal hank. | Yards per pound.   | Yards Weighed. | dwt. | grains.         |
|---------------|--------------------|----------------|------|-----------------|
| ·1250         | = 105              | ..... 6        | = 16 | 16              |
| ·1428         | = 120              | ..... 6        | = 14 | 14              |
| ·1666         | = 140              | ..... 6        | = 12 | 12              |
| ·2083         | = 175              | ..... 6        | = 10 | —               |
| ·2500         | = 210              | ..... 6        | = 8  | 8               |
| ·4375         | = $367\frac{1}{2}$ | ..... 6        | = 6  | $0\frac{1}{4}$  |
| ·5000         | = 420              | ..... 6        | = 4  | 4               |
| ·5625         | = $472\frac{1}{2}$ | ..... 6        | = 3  | $16\frac{3}{4}$ |
| ·6250         | = 525              | ..... 6        | = 3  | 8               |
| ·6870         | = $577\frac{1}{2}$ | ..... 6        | = 3  | $0\frac{3}{8}$  |
| ·7500         | = 630              | ..... 6        | = 2  | $18\frac{5}{8}$ |
| ·8125         | = $682\frac{1}{2}$ | ..... 6        | = 2  | $13\frac{1}{2}$ |

The method of reducing the carding and drawing frame sliver from decimal hank into yards per lb. is as follows: Multiply the decimal hank by the yards per hank—viz., 840—and cut off as many places of decimals on the right as there are in the decimal hank, and the result will be yards per lb. Thus, suppose the decimal hank to be  $25 \times 840 = 210$ ; that is 210 yards per lb.

If 210 yards weigh 1lb., or 7000 grains, what will six yards weigh?

$$\begin{array}{rcl}
 \text{yd.} & \text{gr.} & \text{yd.} \\
 210 & : 7000 & :: 6 \\
 & 6 & \\
 210 & \overline{) 42000} & ( 200 \div 24 = 8 \text{dwt. } 8 \text{gr.} \quad \text{Ans.} \\
 & 420 & \\
 & \hline
 & 00 &
 \end{array}$$



TABLE FOR FINDING THE SIZE OF SLIVERS AND ROVINGS.

| Hanks<br>and<br>Parts | Yards<br>Weigh-<br>ed. | Turns<br>of<br>Reel. | Weight<br>in<br>dwt. gr. |    | Hanks<br>and<br>Parts. | Yards<br>Weigh-<br>ed. | Turns<br>of<br>Reel. | Weight<br>in<br>dwt. gr. |   |
|-----------------------|------------------------|----------------------|--------------------------|----|------------------------|------------------------|----------------------|--------------------------|---|
| $\frac{1}{8}$         | 6                      | 4                    | 18                       | 14 | $4\frac{1}{8}$         | $49\frac{1}{2}$        | 33                   | 4                        | 4 |
| $\frac{1}{7}$         | 6                      | 4                    | 14                       | 14 | $4\frac{1}{4}$         | 51                     | 34                   | 4                        | 4 |
| $\frac{1}{6}$         | 6                      | 4                    | 12                       | 12 | $4\frac{3}{8}$         | $52\frac{1}{2}$        | 35                   | 4                        | 4 |
| $\frac{1}{5}$         | 6                      | 4                    | 9                        | 10 | $4\frac{1}{2}$         | 54                     | 36                   | 4                        | 4 |
| $\frac{1}{4}$         | 6                      | 4                    | 8                        | 8  | $4\frac{5}{8}$         | $55\frac{1}{2}$        | 37                   | 4                        | 4 |
| $\frac{3}{8}$         | 9                      | 6                    | 8                        | 8  | $4\frac{3}{4}$         | 57                     | 38                   | 4                        | 4 |
| $\frac{1}{2}$         | 12                     | 8                    | 8                        | 8  | $4\frac{7}{8}$         | $58\frac{1}{2}$        | 39                   | 4                        | 4 |
| $\frac{5}{8}$         | 15                     | 10                   | 8                        | 8  | 5                      | 60                     | 40                   | 4                        | 4 |
| $\frac{3}{4}$         | 18                     | 12                   | 8                        | 8  | $5\frac{1}{8}$         | $61\frac{1}{2}$        | 41                   | 4                        | 4 |
| $\frac{7}{8}$         | 21                     | 14                   | 8                        | 8  | $5\frac{1}{4}$         | 63                     | 42                   | 4                        | 4 |
| 1                     | 24                     | 16                   | 8                        | 8  | $5\frac{3}{8}$         | $64\frac{1}{2}$        | 43                   | 4                        | 4 |
| $1\frac{1}{8}$        | 27                     | 18                   | 8                        | 8  | $5\frac{1}{2}$         | 66                     | 44                   | 4                        | 4 |
| $1\frac{1}{4}$        | 30                     | 20                   | 8                        | 8  | $5\frac{5}{8}$         | $67\frac{1}{2}$        | 45                   | 4                        | 4 |
| $1\frac{3}{8}$        | 33                     | 22                   | 8                        | 8  | $5\frac{3}{4}$         | 69                     | 46                   | 4                        | 4 |
| $1\frac{1}{2}$        | 36                     | 24                   | 8                        | 8  | $5\frac{7}{8}$         | $70\frac{1}{2}$        | 47                   | 4                        | 4 |
| $1\frac{5}{8}$        | 39                     | 26                   | 8                        | 8  | 6                      | 72                     | 48                   | 4                        | 4 |
| $1\frac{3}{4}$        | 42                     | 28                   | 8                        | 8  | $6\frac{1}{8}$         | $73\frac{1}{2}$        | 49                   | 4                        | 4 |
| $1\frac{7}{8}$        | 45                     | 30                   | 8                        | 8  | $6\frac{1}{4}$         | 75                     | 50                   | 4                        | 4 |
| 2                     | 48                     | 32                   | 8                        | 8  | $6\frac{3}{8}$         | $76\frac{1}{2}$        | 51                   | 4                        | 4 |
| $2\frac{1}{8}$        | 51                     | 34                   | 8                        | 8  | $6\frac{1}{2}$         | 78                     | 52                   | 4                        | 4 |
| $2\frac{1}{4}$        | 54                     | 36                   | 8                        | 8  | $6\frac{5}{8}$         | $79\frac{1}{2}$        | 53                   | 4                        | 4 |
| $2\frac{3}{8}$        | 57                     | 38                   | 8                        | 8  | $6\frac{3}{4}$         | 81                     | 54                   | 4                        | 4 |
| $2\frac{1}{2}$        | 60                     | 40                   | 8                        | 8  | $6\frac{7}{8}$         | $82\frac{1}{2}$        | 55                   | 4                        | 4 |
| $2\frac{5}{8}$        | 63                     | 42                   | 8                        | 8  | 7                      | 84                     | 56                   | 4                        | 4 |
| $2\frac{3}{4}$        | 66                     | 44                   | 8                        | 8  | $7\frac{1}{8}$         | $85\frac{1}{2}$        | 57                   | 4                        | 4 |
| $2\frac{7}{8}$        | 69                     | 46                   | 8                        | 8  | $7\frac{1}{4}$         | 87                     | 58                   | 4                        | 4 |
| 3                     | 72                     | 48                   | 8                        | 8  | $7\frac{3}{8}$         | $88\frac{1}{2}$        | 59                   | 4                        | 4 |
| $3\frac{1}{8}$        | 75                     | 50                   | 8                        | 8  | $7\frac{1}{2}$         | 90                     | 60                   | 4                        | 4 |
| $3\frac{1}{4}$        | 78                     | 52                   | 8                        | 8  | $7\frac{5}{8}$         | $91\frac{1}{2}$        | 61                   | 4                        | 4 |
| $3\frac{3}{8}$        | 81                     | 54                   | 8                        | 8  | $7\frac{3}{4}$         | 93                     | 62                   | 4                        | 4 |
| $3\frac{1}{2}$        | 84                     | 56                   | 8                        | 8  | $7\frac{7}{8}$         | $94\frac{1}{2}$        | 63                   | 4                        | 4 |
| $3\frac{5}{8}$        | 87                     | 58                   | 8                        | 8  | 8                      | 96                     | 64                   | 4                        | 4 |
| $3\frac{7}{8}$        | 90                     | 60                   | 8                        | 8  | $8\frac{1}{8}$         | $97\frac{1}{2}$        | 65                   | 4                        | 4 |
| $3\frac{3}{4}$        | 93                     | 62                   | 8                        | 8  | $8\frac{1}{4}$         | 99                     | 66                   | 4                        | 4 |
| 4                     | 96                     | 64                   | 8                        | 8  | $8\frac{3}{8}$         | $100\frac{1}{2}$       | 67                   | 4                        | 4 |



TABLE FOR FINDING THE SIZE OF ROVINGS.

| Hanks<br>and<br>Parts. | Yards<br>Weigh-<br>ed. | Turns<br>of<br>Reel. | Weight<br>in<br>dwt. gr. |   | Hanks<br>and<br>Parts. | Yards<br>Weigh-<br>ed. | Turns<br>of<br>Reel. | Weight<br>in<br>dwt. gr. |   |
|------------------------|------------------------|----------------------|--------------------------|---|------------------------|------------------------|----------------------|--------------------------|---|
| $8\frac{1}{2}$         | 51                     | 34                   | 2                        | 2 | 16                     | 48                     | 32                   | 1                        | 1 |
| $8\frac{5}{8}$         | $51\frac{3}{4}$        | $34\frac{1}{2}$      | 2                        | 2 | 17                     | 51                     | 34                   | 1                        | 1 |
| $8\frac{3}{4}$         | $52\frac{1}{2}$        | 35                   | 2                        | 2 | 18                     | 54                     | 36                   | 1                        | 1 |
| $8\frac{7}{8}$         | $53\frac{1}{4}$        | $35\frac{1}{2}$      | 2                        | 2 | 19                     | 57                     | 38                   | 1                        | 1 |
| 9                      | 54                     | 36                   | 2                        | 2 | 20                     | 60                     | 40                   | 1                        | 1 |
| $9\frac{1}{8}$         | $54\frac{3}{4}$        | $36\frac{1}{2}$      | 2                        | 2 | 21                     | 63                     | 42                   | 1                        | 1 |
| $9\frac{1}{4}$         | $55\frac{1}{2}$        | 37                   | 2                        | 2 | 22                     | 66                     | 44                   | 1                        | 1 |
| $9\frac{3}{8}$         | $56\frac{1}{4}$        | $37\frac{1}{2}$      | 2                        | 2 | 23                     | 69                     | 46                   | 1                        | 1 |
| $9\frac{1}{2}$         | 57                     | 38                   | 2                        | 2 | 24                     | 72                     | 48                   | 1                        | 1 |
| $9\frac{5}{8}$         | $57\frac{3}{4}$        | $38\frac{1}{2}$      | 2                        | 2 | 25                     | 75                     | 50                   | 1                        | 1 |
| $9\frac{3}{4}$         | $58\frac{1}{2}$        | 39                   | 2                        | 2 | 26                     | 78                     | 52                   | 1                        | 1 |
| $9\frac{7}{8}$         | $59\frac{1}{4}$        | $39\frac{1}{2}$      | 2                        | 2 | 27                     | 81                     | 54                   | 1                        | 1 |
| 10                     | 60                     | 40                   | 2                        | 2 | 28                     | 84                     | 56                   | 1                        | 1 |
| $10\frac{1}{8}$        | $60\frac{3}{4}$        | $40\frac{1}{2}$      | 2                        | 2 | 29                     | 87                     | 58                   | 1                        | 1 |
| $10\frac{1}{4}$        | $61\frac{1}{2}$        | 41                   | 2                        | 2 | 30                     | 90                     | 60                   | 1                        | 1 |
| $10\frac{3}{8}$        | $62\frac{1}{4}$        | $41\frac{1}{2}$      | 2                        | 2 | 31                     | 93                     | 62                   | 1                        | 1 |
| $10\frac{1}{2}$        | 63                     | 42                   | 2                        | 2 | 32                     | 96                     | 64                   | 1                        | 1 |
| $10\frac{5}{8}$        | $63\frac{3}{4}$        | $42\frac{1}{2}$      | 2                        | 2 | 33                     | 99                     | 66                   | 1                        | 1 |
| $10\frac{3}{4}$        | $64\frac{1}{2}$        | 43                   | 2                        | 2 | 34                     | 102                    | 68                   | 1                        | 1 |
| $10\frac{7}{8}$        | $65\frac{1}{4}$        | $43\frac{1}{2}$      | 2                        | 2 | 35                     | 105                    | 70                   | 1                        | 1 |
| 11                     | 66                     | 44                   | 2                        | 2 | 36                     | 108                    | 72                   | 1                        | 1 |
| $11\frac{1}{8}$        | $66\frac{3}{4}$        | $44\frac{1}{2}$      | 2                        | 2 | 37                     | 111                    | 74                   | 1                        | 1 |
| $11\frac{1}{4}$        | $67\frac{1}{2}$        | 45                   | 2                        | 2 | 38                     | 114                    | 76                   | 1                        | 1 |
| $11\frac{3}{8}$        | $68\frac{1}{4}$        | $45\frac{1}{2}$      | 2                        | 2 | 39                     | 117                    | 78                   | 1                        | 1 |
| $11\frac{1}{2}$        | 69                     | 46                   | 2                        | 2 | 40                     | 120                    | 80                   | 1                        | 1 |
| $11\frac{5}{8}$        | $69\frac{3}{4}$        | $46\frac{1}{2}$      | 2                        | 2 | 41                     | 123                    | 82                   | 1                        | 1 |
| $11\frac{3}{4}$        | $70\frac{1}{2}$        | 47                   | 2                        | 2 | 42                     | 126                    | 84                   | 1                        | 1 |
| $11\frac{7}{8}$        | $71\frac{1}{4}$        | $47\frac{1}{2}$      | 2                        | 2 | 43                     | 129                    | 86                   | 1                        | 1 |
| 12                     | 72                     | 48                   | 2                        | 2 | 44                     | 132                    | 88                   | 1                        | 1 |
| $12\frac{1}{4}$        | $73\frac{1}{2}$        | 49                   | 2                        | 2 | 45                     | 135                    | 90                   | 1                        | 1 |
| $12\frac{1}{2}$        | 75                     | 50                   | 2                        | 2 | 46                     | 138                    | 92                   | 1                        | 1 |
| $12\frac{3}{4}$        | $76\frac{1}{2}$        | 51                   | 2                        | 2 | 47                     | 141                    | 94                   | 1                        | 1 |
| 13                     | 78                     | 52                   | 2                        | 2 | 48                     | 144                    | 96                   | 1                        | 1 |
| 14                     | 84                     | 56                   | 2                        | 2 | 49                     | 147                    | 98                   | 1                        | 1 |
| 15                     | 90                     | 60                   | 2                        | 2 | 50                     | 150                    | 100                  | 1                        | 1 |



## ROVING-FRAMES.

All roving-frames are similar in construction, whether they be slubbing, intermediate, or fine roving-frames. Each of them may be considered as drawing-frames, as they are for the purpose of reducing the size of the thread gradually finer and finer, without using too large a draught in any one place, and at the same time to afford a chance of doubling at the intermediate and fine roving-frames (essentially necessary for producing a good yarn). The slubbing-frame is for making coarse roving, and is the first machine to give twist for increasing the cohesive strength of the roving. Doubling at the slubbing-frame is not necessary, on account of the sliver having been doubled at the front of the drawing-frame. It would be all the better to use the stopping motion at the slubbing-frames to prevent the ends from passing through the rollers, and causing piecings to be made at the front which can be much better made at the back. There should be as few piecings made at the front as possible; and what piecings are made there should be made by twisting the ends together at the front rollers, instead of making clumsy piecings at the bobbins, which rarely pass through the next operation without breaking or causing a bad place in the roving or thread. There is another evil peculiar to roving-frames which is caused by allowing the slit in the top of the spindle to get partly filled with fly and dirt. This has a very damaging effect on both the spindles and flyers, and prevents the flyers from going down to their proper places on the spindles, so that the flyers get loose and begin to waddle about, and in course of time both spindles and flyers are so much galled by working loose that they become very unsteady, and cause many bad bobbins to be made, besides an increase of waste and piecings, as well as a considerable loss in the quantity of work. The flyer, by working loose, has the following effect—it is apt to rise above its proper place, and by so doing it winds beyond the ridge of the bobbin, letting the roving slack till it begins to coil on the top of the flyer, so when the lifter returns it to the full size of the bobbin it cannot take up the roving on account of its being fast in the coil, consequently the roving breaks, and of course a stoppage takes place while the roving is being pieced. To remedy this evil (for evil it is) I would recommend the slit in the top of the spindles to be cleaned out about every three months. It is easily done by a keyhole saw. The flyer-frame is decidedly the most complete and economical machine for making roving ever yet invented, and, as they are made at the present time, there is scarcely any room for improvement. To contemplate the beautiful simplicity of the mechanical arrangement is very pleasing, especially in the differential motion, which is for the purpose of regulating the speed of the bobbins according



to their increasing diameter. This is effected by moving the strap connected with the upper cone (which always revolves at one uniform speed) and the lower cone, decreasing its speed at every change of the traverse, either ascending or descending, and by so doing increasing the speed of the bobbins, while at the same time the taking-up speed of the bobbins remains the same. This arises from the difference of speed between the spindles and bobbins. It is requisite that the bobbins should go as much slower than the spindles as only just to take up the roving delivered by the rollers, so that the increasing diameter of the bobbins requires an increase of speed to lessen the difference between the spindles and bobbins. The cones should be formed by a parabolic curve of mathematical correctness. Both cones are formed by the same curve, but reverse of each other—that is, the upper or driving cone is hollow in its length, while the curved line of the lower or driven cone bulges outwards. This curvature is absolutely necessary to make compensation for having an equally divided rack; otherwise, if the cones were a straight taper, the winding would be too great when the strap arrives at the middle of the cones, and would cause considerable stretching in the roving, and the winding could not possibly be correct at any part of the bobbin except at the beginning and ending of the bobbin; hence the necessity of using the parabolic cones. They have just the same effect with respect to winding or taking-up of the roving as the straight tapering single cone has, but are far superior in their action to the single cone in several material respects. In the first place the strap is always of one uniform tension or tightness, which causes more regularity in winding on the roving, and the power is two to one in favour of the two cones over the single cone. The single cone is very unsteady in its action in consequence of the swinging motion of the heavy lever and pulley, which were intended for keeping the strap at one certain tightness. The method of finding the proper quantity of twist per inch is by multiplying the square root of the hank roving by 1.2, and for finding the number of laps per inch in the length of the bobbin by multiplying the twist per inch by 7.75. The same will be found ready worked out in the roving-frame tables; in fact the principal information will be found there. By looking for the counts of yarn in the top line all particulars respecting slubbing, intermediate, and fine roving may be seen under the hanks of yarn they are required for. There is much diversity of opinion with respect to the quantity of twist necessary to put into roving. Some say as little as possible, provided there is sufficient to give it strength to unrove from the bobbins without straining. To this I decidedly disagree, for it is more subject to straining in winding on than by unroving from the bobbins. There should not be the least imaginable draught between the



rollers and the bobbins, for if there is it is impossible to produce a good level roving, and the previous labour bestowed on it for making a good roving is destroyed, and consequently a very inferior yarn is obtained requiring a greater amount of twist than is necessary for good yarn. I will here mention a case in point which was an occurrence in my own experience, and was discovered in the following manner: I received a note to the effect that the yarn (weft) was short of twist, or "soft," as it was termed in the note. I could not conceive how it could be short of twist. I was so confident that I took the note to the overlooker of the roving-frames and bid him read it, which he did, and he very complacently asked me what that note had to do with him; and he made the remark that if the yarn was short of twist it would, of course, be out of his limits to rectify it. I fully assured him that the twist in the yarn was all right, and the mischief was being done in the roving-frame by a considerable draught between the rollers and bobbins. "Oh," said he, "it cannot be that; feel how soft the bobbins are." I asked what draught there was in the rollers. He did not know. However that point was soon determined, and proved to be a draught of one into six, which ought to have been one into seven, so that one-seventh of the draught was taking place between the rollers and bobbins. I asked him how he could account for it. He could not account for it. I told him it was an easy matter to do so. He had been trying to make the bobbins hard and had failed for want of twist. The fault appeared so clear against him that he gave notice and left to prevent himself from being discharged. I hope this digression may be excused on account of the beneficial effect it may have on the minds of those having roving-frames under their care, showing them that they cannot make hard bobbins with impunity without having sufficient twist to warrant it. No spinner or minder will ever complain of the roving being too hard twisted providing the rollers are set at a proper distance from each other. The proper distance from centre to centre of the rollers depends upon four conditions, viz., length of staple or fibre, thickness or substance to be operated on, the quantity of twist in the roving, and the quantity of draught. In general, the rule is to add one-eighth of an inch to the length of the fibre. If the substance be great it requires a greater distance; if it be small a shorter distance. An extra quantity of twist in the roving requires a greater distance, while slackly-twisted roving requires a shorter; a very small draught a greater distance, and a very large draught a shorter distance. From this it appears to depend on circumstances what distance there shall be between the rollers. This matter I will leave to the discretionary judgment of the managers and overlookers.



I will now proceed to examine the principal particulars of a four-hank intermediate roving-frame. I find in the table the revolutions of the spindles to be 750 per minute; the twist per inch 2.4; diameter of front roller 1.125in.; and diameter of tubes empty 1.1875in.; diameter of bobbins full 3.5in. The revolutions of the spindles being 750 per minute, what will be the revolutions per minute of the frame shaft? (Frame shaft wheel 50 teeth driving 48 on spindle shaft, bevel wheel on spindle shaft of 60 teeth driving spindle wheel of 29 teeth.)

$$\begin{array}{l} \text{Drivers } 750 \times 48 \times 29 = 1044000 \\ \text{Driven } \frac{60 \times 50 = 3000}{1044000} = 348 \text{ revolutions of frame} \\ \text{shaft per minute.} \end{array}$$

The frame shaft makes 348 revolutions per minute; how many revolutions per minute will the spindles make from following wheels? (Frame shaft wheel of 50 teeth, spindle shaft wheel of 48 teeth, spindle shaft bevel wheel of 60 teeth, and spindle bevel wheels of 29 teeth.)

$$\begin{array}{l} \text{Drivers } 348 \times 50 \times 60 = 1044000 \\ \text{Driven } \frac{48 \times 29 = 1392}{1044000} = 750 \text{ revolutions of} \\ \text{spindles.} \end{array}$$

If the twist wheel of 32 teeth on the frame shaft makes 348 revolutions per minute, how many revolutions per minute will the top cone make with a wheel of 42 teeth?  $348 \times 32 = 11136 \div 42 = 265.142857$ , the uniform speed of the top cone. If the top cone makes the above revolutions per minute with a wheel of 40 teeth, how many revolutions per minute will the front rollers make with a wheel of 120 teeth?  $265.142857 \times 40 = 10605.71428 \div 120 = 88.3809$ . If the diameter of the front rollers be 1.25, the circumference will be  $3.5343 \times 88.3809 = 312.3646$  inches delivered by the front rollers per minute. If the inches delivered per minute be multiplied by the twist per inch, it will give the revolutions per minute of the spindles or nearly so; thus  $312.3646 \times 2.4 = 749.67404$ . The differential motion consists of the following wheels, viz., a mitre wheel of about seven inches diameter, fastened on the frame shaft, working into two other mitre wheels of the same size, carried by the central bevel wheel of 120 teeth. The two mitres gear into another mitre wheel fastened on the end of the socket, which runs loose on the frame shaft, and conveys the motion to the bobbin shaft by a spur wheel of 50 teeth made fast on the other end of the socket, driving through two carrier wheels, one placed on the joint pin of the dog-leg lever, and the other placed so as to gear into the joint pin wheel and the wheel on the end of the bobbin shaft of 48 teeth; the bevel wheels of 60 teeth on the bobbin shaft gear into the bobbin wheels of 29 teeth, which would make the same revolutions per minute as the spindles,



if the central bevel wheel remained stationary while the other part of the machine is in motion ; consequently no winding-on whatever could take place ; but if the central bevel wheel be allowed to move in the same direction as the frame shaft then one revolution of the central bevel wheel will have the effect of slowing the motion of the socket two revolutions.

Then the question will be, how much the central bevel wheel must be allowed to move, to give the bobbins the correct number of revolutions that they ought to go slower than the spindles for the proper taking up of the roving as it is delivered by the front rollers, without straining the thread. If the top cone be 5.26655 in diameter and makes 265.142857 revolutions per minute, how many revolutions per minute will the bottom cone make at 3.23345 inches diameter? The answer is 431.857. This is the speed requisite for the first layer on the bare tubes of 1.1875 inch diameter.

If the tubes be 1.1875 inches diameter, what will be their revolutions per minute? The diameter of tubes  $1.1875 \times 3.1416 = 3.73065 \times 2.4 = 8.95356$  twist for one revolution of the bare tubes. Then,  $750 \div 8.95356 = 83.7655$ , the difference of speed between the empty tubes and the spindles ; then the speed of the spindle being  $750 - 83.7655 = 666.2345$ , the revolutions per minute of the empty tubes. If the empty tubes make 666.2345 revolutions per minute, how many revolutions per minute should the socket make from the following wheels, viz., bobbin wheels 29 teeth, bobbin-shaft bevel wheels of 60 teeth, spur-wheel on the end of the bobbin shaft of 48 teeth, and the spur-wheel on the socket of 50 teeth. Then, as the tubes make 666.2345 revolutions per minute, the case will stand thus—

$$\frac{666.2345 \times 29 \times 48}{60 \times 50} = \frac{927398.2848}{3000} = 309.13276. \text{ Ans.}$$

What is the difference of speed between the frame shaft and the socket? Speed of frame shaft,  $348 - 309.13276 = 38.86724$ . Then  $38.86724 \div 2 = 19.43362$  = the revolutions per minute of the central bevel wheel. If the central bevel wheel of 120 teeth makes 19.43362 revolutions per minute, how many revolutions per minute will the short upright shaft make with a wheel of 27 teeth?  $19.43362 \times 120 = 2332.0344 \div 27 = 86.37164$ . If there be a wheel on the upright shaft of 100 teeth, making 86.37164 revolutions per minute, how many revolutions per minute will the bottom cone make with a wheel of 20 teeth?

$$86.37164 \times 100 = 8637.164 \div 20 = 431.8582. \text{ Ans.}$$



If the bottom cone makes 431·8582 revolutions per minute for the bare tubes, how many revolutions per minute will it make for the full bobbins of 3·5 inches diameter? 146·5233 (the Answer.) How many laps per inch will there be on the bobbins from the following particulars? The traverse motion is driven by a bevel wheel on the bottom end of the short upright shaft of 20 teeth, making 83·37164 revolutions per minute, driving through a train of wheels in the following manner, viz.: A pair of bevel wheels of 100 teeth each, one fastened on the pap or socket of the other (these wheels are made use of for reversing the lifting rail up or down, by gearing into the 20 wheel on the upright shaft alternately; they slide loose on the reversing shaft, but at the same time take it round with them); there is a spur wheel of 20 teeth on the reversing shaft working into a double carrier of 60 and 25 teeth, the 25-teeth wheel working into another double carrier of 60 and 24 teeth, the 24 driving the lifting wheel of 100 teeth, the lifting shaft will make ·57608887 of a revolution per minute, with lifting wheels of 20 teeth each, and 8 to the inch pitch; one revolution of the lifting wheels will give 7·854 inches. Multiply the driving wheels together for a dividend, and the driven together for a divisor, and the quotient will be ·57608887 of a revolution per minute.

$$\begin{array}{l} \text{Thus,} \quad 83\cdot37164 \times 20 \times 20 \times 25 \times 2 = 20719194\cdot6 \\ \text{Driven,} \quad \frac{100 \times 60 \times 60 \times 100}{= 36000000} = \cdot57608887. \end{array}$$

Then  $\cdot5760888 \times 7\cdot854 = 4\cdot68$  inches of traverse in one minute. The difference per minute between the spindles and tube is  $83\cdot7655 \div 4\cdot68 = 18\cdot6$  laps per inch on the tubes. Suppose the slubbing-roving to be  $1\frac{3}{8}$  hank, or 1·375 put up double to the intermediate frame, what will be the draught required to make it into a 4-hank intermediate roving?

$$\text{Thus, } 1\cdot375 \div 2 = \cdot6875. \quad \text{Then } 4 \div \cdot6875 = 5\cdot81. \quad \text{Ans.}$$

If the front rollers are  $1\frac{1}{8}$ , or 1·125 diameter, with a pinion of 34 teeth driving the stud-wheel of 108 teeth, and back roller 1 inch diameter, with a wheel of 52 teeth, what number of teeth will the change-pinion have in it to bring out the above draught?

$$\begin{array}{l} \text{Driven } 1\cdot125 \times 52 \times 108 = 6318 \\ \text{Drivers } \frac{5\cdot81 \times 34}{= 197\cdot54} = 32 \text{ nearly.} \end{array}$$

In changing the scape-wheel it should be as the square root of the hank roving. Suppose for 4-hank roving we have a scape-wheel of 12 teeth, what would a 3-hank roving require? The square root of 4-hank is 2, and the square root of 3-hank is  $1\cdot7347 \times 12 = 20\cdot8164 \div 2 = 10$  scape-wheel for 3-hank roving. The twist-wheel is governed in like manner, but in inverse proportion.



CONES.

Calculated for any size of bobbins that are necessary to be made on roving-frames, giving the diameters at equal divisions of their length, the increasing size of the bobbin with the various revolutions of the bottom cone.

| Increasing<br>size of the<br>Bobbins. | Uniform speed<br>237·3737     |        | Variable speed.                  |  | Revolutions<br>of the<br>Bottom Cone<br>per<br>minute. |
|---------------------------------------|-------------------------------|--------|----------------------------------|--|--------------------------------------------------------|
|                                       | Diameters of the<br>Top Cone. |        | Diameters of the<br>Bottom Cone. |  |                                                        |
| 1·235                                 | 3·7500                        | Layers | 2·7500                           |  | 500·0000                                               |
| 1·370                                 | 5·5536                        | 1      | 2·9464                           |  | 450·7299                                               |
| 1·505                                 | 5·3700                        | 2      | 3·1300                           |  | 410·2990                                               |
| 1·640                                 | 5·1984                        | 3      | 3·3016                           |  | 376·5243                                               |
| 1·775                                 | 5·0374                        | 4      | 3·4626                           |  | 347·8872                                               |
| 1·910                                 | 4·8861                        | 5      | 3·6139                           |  | 323·2984                                               |
| 2·045                                 | 4·7436                        | 6      | 3·7564                           |  | 301·9559                                               |
| 2·180                                 | 4·6101                        | 7      | 3·8899                           |  | 283·2614                                               |
| 2·315                                 | 4·4794                        | 8      | 4·0206                           |  | 266·6666                                               |
| 2·450                                 | 4·3618                        | 9      | 4·1382                           |  | 252·0408                                               |
| 2·585                                 | 4·2477                        | 10     | 4·2523                           |  | 238·8781                                               |
| 2·720                                 | 4·1399                        | 11     | 4·3601                           |  | 227·0588                                               |
| 2·855                                 | 4·0368                        | 12     | 4·4632                           |  | 216·2872                                               |
| 2·990                                 | 3·9390                        | 13     | 4·5610                           |  | 206·5217                                               |
| 3·125                                 | 3·8458                        | 14     | 4·6542                           |  | 197·6000                                               |
| 3·260                                 | 3·7803                        | 15     | 4·7197                           |  | 188·4171                                               |
| 3·395                                 | 3·6721                        | 16     | 4·8279                           |  | 181·8851                                               |
| 3·530                                 | 3·5910                        | 17     | 4·9090                           |  | 174·9291                                               |
| 3·665                                 | 3·5134                        | 18     | 4·9865                           |  | 168·4856                                               |
| 3·800                                 | 3·4124                        | 19     | 5·0876                           |  | 160·3947                                               |
| 3·935                                 | 3·3678                        | 20     | 5·1322                           |  | 156·9250                                               |
| 4·070                                 | 3·2995                        | 21     | 5·2006                           |  | 151·7199                                               |
| 4·205                                 | 3·2359                        | 22     | 5·2641                           |  | 146·8490                                               |
| 4·340                                 | 3·1708                        | 23     | 5·3292                           |  | 142·2811                                               |
| 4·475                                 | 3·1101                        | 24     | 5·3899                           |  | 137·9888                                               |
| 4·610                                 | 3·0515                        | 25     | 5·4485                           |  | 133·9479                                               |
| 4·745                                 | 2·9955                        | 26     | 5·5045                           |  | 130·1369                                               |
| 4·880                                 | 2·9413                        | 27     | 5·5587                           |  | 126·5368                                               |
| 5·015                                 | 2·8889                        | 28     | 5·6111                           |  | 123·1306                                               |
| 5·150                                 | 2·8386                        | 29     | 5·6614                           |  | 119·9029                                               |
| 5·285                                 | 2·7927                        |        | 5·7073                           |  | 116·8401                                               |



ROVING-FRAME TABLES.

*Slubbing-frame suitable for yarn of the following numbers, viz., from 6 to 20 hanks in the pound. The produce is given in pounds, and decimal parts of a pound, allowing 50 hours per week.*

| HANKS OF YARN IN THE POUND.....                          | 6                   | 7-8           | 9-10          | 11-12         | 13-14         |
|----------------------------------------------------------|---------------------|---------------|---------------|---------------|---------------|
| Hank slubbing in the pound .....                         | $\frac{1}{2}$       | $\frac{1}{2}$ | $\frac{1}{2}$ | $\frac{1}{2}$ | $\frac{5}{8}$ |
| Twist in the slubbing per inch ...                       | ·848                | ·848          | ·848          | ·848          | ·948          |
| Decimal hank of drawing-frame }<br>sliver .....          | ·125                | ·125          | ·125          | ·125          | ·125          |
| Draught in the rollers .....                             | 4                   | 4             | 4             | 4             | 5             |
| Diameter of the front rollers .....                      | 1 $\frac{1}{4}$ in. | ...           | ...           | ...           | ...           |
| Diameter of the tubes empty .....                        | 1 $\frac{3}{8}$ in. | ...           | ...           | ...           | ...           |
| Diameter of the bobbins when full                        | 5in.                | ...           | ...           | ...           | ...           |
| Length of the lift or traverse.....                      | 10in.               | ...           | ...           | ...           | ...           |
| Laps per inch in the traverse.....                       | 6·57                | ...           | ...           | ...           | 7·35          |
| Diameter of the spindles.....                            | $\frac{3}{4}$ in.   | ...           | ...           | ...           | ...           |
| Revolutions of the spindles per }<br>minute .....        | 500                 | ...           | ...           | ...           | ...           |
| Revolutions of spindles for one }<br>of the rollers..... | 3·33                | ...           | ...           | ...           | 3·722         |
| Produce per spindle per week of }<br>50 hours .....      | 117lb.              | ...           | ...           | ...           | 83·71         |

| HANKS OF YARN IN THE POUND.....                           | 15-16               | 17            | 18            | 19            | 20            |
|-----------------------------------------------------------|---------------------|---------------|---------------|---------------|---------------|
| Hank slubbing in the pound .....                          | $\frac{3}{4}$       | $\frac{3}{4}$ | $\frac{3}{4}$ | $\frac{3}{4}$ | $\frac{3}{4}$ |
| Twist in the slubbing per inch ...                        | 1·039               | 1·039         | 1·039         | 1·039         | 1·039         |
| Decimal hank of drawing-frame }<br>sliver .....           | ·125                | ·125          | ·125          | ·125          | ·125          |
| Draught in the rollers.....                               | 6                   | 6             | 6             | 6             | 6             |
| Diameter of the front rollers .....                       | 1 $\frac{1}{4}$ in. | ...           | ...           | ...           | ...           |
| Diameter of the tubes empty .....                         | 1 $\frac{3}{8}$ in. | ...           | ...           | ...           | ...           |
| Diameter of the bobbins when full                         | 5in.                | ...           | ...           | ...           | ...           |
| Length of the lift or traverse.....                       | 10in.               | ...           | ...           | ...           | ...           |
| Laps per inch in the traverse .....                       | 8·05                | ...           | ...           | ...           | ...           |
| Diameter of the spindles.....                             | $\frac{3}{4}$ in.   | ...           | ...           | ...           | ...           |
| Revolutions of the spindles per }<br>minute .....         | 500                 | ...           | ...           | ...           | ...           |
| Revolutions of spindles for one }<br>of the rollers ..... | 4·070               | ...           | ...           | ...           | ...           |
| Produce per spindle per week of }<br>50 hours .....       | 63·78               | ...           | ...           | ...           | ...           |



## ROVING-FRAME TABLES.

*Slubbing-frame suitable for yarn of the following numbers, viz., from 22 to 40 hanks in the pound. The produce is given in pounds and decimal parts of a pound, allowing 50 hours per week.*

| HANKS OF YARN IN THE POUND.....                      | 22                  | 24            | 26            | 28            | 30            |
|------------------------------------------------------|---------------------|---------------|---------------|---------------|---------------|
| Hanks of slubbing roving in the pound.....           | $\frac{5}{8}$       | $\frac{5}{8}$ | $\frac{5}{8}$ | $\frac{3}{4}$ | $\frac{3}{4}$ |
| Twist per inch in the slubbing ...                   | ·948                | ·948          | ·948          | 1·03          | 1·03          |
| Decimal hank of drawing-frame sliver .....           | ·125                | ·125          | ·125          | ·1428         | ·1428         |
| Draught in the rollers .....                         | 5                   | 5             | 5             | 5             | 5·25          |
| Diameter of the front rollers.....                   | 1 $\frac{1}{4}$ in. | ...           | ...           | ...           | ...           |
| Diameter of the tubes empty .....                    | 1 $\frac{3}{8}$ in. | ...           | ...           | ...           | ...           |
| Diameter of the bobbins when full                    | 5in.                | ...           | ...           | ...           | ...           |
| Laps per inch in the lift .....                      | 7·35                | 7·35          | 7·35          | 8·05          | 8·05          |
| Length of the lift or traverse .....                 | 10in.               | ...           | ...           | ...           | ...           |
| Diameter of the spindles.....                        | $\frac{3}{4}$ in.   | ...           | ...           | ...           | ...           |
| Revolutions of the spindles per minute .....         | 500                 | ...           | ...           | ...           | ...           |
| Revolutions of spindles for one of the rollers ..... | 3·72                | 3·72          | 3·72          | 4·04          | 4·04          |
| Produce per spindle per week.....                    | 83·71               | 83·71         | 83·71         | 63·78         | 63·78         |

  

| HANKS OF YARN IN THE POUND.....                      | 32                  | 34            | 36    | 38    | 40    |
|------------------------------------------------------|---------------------|---------------|-------|-------|-------|
| Hanks of slubbing roving in the pound.....           | $\frac{3}{4}$       | $\frac{7}{8}$ | 1     | 1     | 1     |
| Twist per inch in the slubbing ...                   | 1·03                | 1·12          | 1·20  | 1·20  | 1·20  |
| Decimal hank of drawing-frame sliver .....           | ·1428               | ·1666         | ·1666 | ·1666 | ·1666 |
| Draught in the rollers.....                          | 5·25                | 5·25          | 6     | 6     | 6     |
| Diameter of the rollers.....                         | 1 $\frac{1}{4}$ in. | ...           | ...   | ...   | ...   |
| Diameter of the tubes empty .....                    | 1 $\frac{3}{8}$ in. | ...           | ...   | ...   | ...   |
| Diameter of the bobbins when full                    | 5in.                | ...           | ...   | ...   | ...   |
| Laps per inch in the lift .....                      | 8·05                | 8·69          | 9·30  | 9·30  | 9·30  |
| Length of the lift or traverse .....                 | 10in.               | ...           | ...   | ...   | ...   |
| Diameter of the spindles.....                        | $\frac{3}{4}$ in.   | ...           | ...   | ...   | ...   |
| Revolutions of the spindles per minute .....         | 500                 | ...           | ...   | ...   | ...   |
| Revolutions of spindles for one of the rollers ..... | 4·04                | 4·39          | 4·71  | 4·71  | 4·71  |
| Produce per spindle per week.....                    | 63·78               | 50·61         | 41·33 | 41·33 | 41·33 |



## ROVING-FRAME TABLES.

*Slubbing-frame suitable for yarn of the following numbers, viz., from 42 to 75 hanks in the pound. The produce is given in pounds and decimal parts of a pound, allowing 50 hours per week.*

| HANKS OF YARN IN THE POUND.....                           | 42                  | 44    | 46    | 48    | 50    |
|-----------------------------------------------------------|---------------------|-------|-------|-------|-------|
| Hanks of slubbing in the pound...                         | 1                   | 1     | 1     | 1     | 1     |
| Twist per inch in the slubbing ...                        | 1·20                | 1·20  | 1·20  | 1·20  | 1·20  |
| Decimal hank of drawing-frame }<br>sliver .....           | ·1666               | ·1666 | ·1666 | ·1666 | ·1666 |
| Draught in the rollers.....                               | 6                   | 6     | 6     | 6     | 6     |
| Diameter of the front rollers .....                       | 1 $\frac{1}{4}$ in. | ...   | ...   | ...   | ...   |
| Diameter of the tubes empty .....                         | 1 $\frac{3}{8}$ in. | ...   | ...   | ...   | ...   |
| Diameter of the bobbins when full                         | 4 $\frac{1}{2}$ in. | ...   | ...   | ...   | ...   |
| Laps per inch in the lift.....                            | 9·30                | ...   | ...   | ...   | ...   |
| Length of the lift or traverse .....                      | 9in.                | ...   | ...   | ...   | ...   |
| Diameter of the spindles.....                             | $\frac{3}{4}$ in.   | ...   | ...   | ...   | ...   |
| Revolutions of the spindles per }<br>minute .....         | 545                 | ...   | ...   | ...   | ...   |
| Revolutions of spindles for one of }<br>the rollers ..... | 4·71                | ...   | ...   | ...   | ...   |
| Produce per spindle per week.....                         | 45·05               | ...   | ...   | ...   | ...   |

  

| HANKS OF YARN IN THE POUND.....                           | 55                  | 60    | 65              | 70              | 75              |
|-----------------------------------------------------------|---------------------|-------|-----------------|-----------------|-----------------|
| Hanks of slubbing in the pound...                         | 1                   | 1     | 1 $\frac{1}{8}$ | 1 $\frac{1}{4}$ | 1 $\frac{1}{4}$ |
| Twist per inch in the slubbing ...                        | 1·20                | 1·20  | 1·27            | 1·34            | 1·34            |
| Decimal hank of drawing-frame }<br>sliver .....           | ·2083               | ·2083 | ·2083           | ·2083           | ·2083           |
| Draught in the rollers.....                               | 4·80                | 4·80  | 5·40            | 6               | 6               |
| Diameter of the front rollers .....                       | 1 $\frac{1}{4}$ in. | ...   | ...             | ...             | ...             |
| Diameter of the tubes empty.....                          | 1 $\frac{3}{8}$ in. | ...   | ...             | ...             | ...             |
| Diameter of the bobbins when full                         | 4 $\frac{1}{2}$ in. | ...   | ...             | ...             | ...             |
| Laps per inch in the lift.....                            | 9·30                | 9·30  | 9·86            | 10·39           | 10·39           |
| Length of the lift or traverse.....                       | 9in.                | ...   | ...             | ...             | ...             |
| Diameter of the spindles.....                             | $\frac{3}{4}$ in.   | ...   | ...             | ...             | ...             |
| Revolutions of the spindles per }<br>minute .....         | 545                 | ...   | ...             | ...             | ...             |
| Revolutions of spindles for one of }<br>the rollers ..... | 4·71                | 4·71  | 4·98            | 5·26            | 5·26            |
| Produce per spindle per week.....                         | 45·05               | 45·05 | 37·84           | 32·27           | 32·27           |



## ROVING-FRAME TABLES.

*Slubbing-frame suitable for yarn of the following numbers, viz., from 80 to 150 hanks in the pound. The produce is given in pounds and decimal parts of a pound, allowing 50 hours per week.*

| HANKS OF YARN IN THE POUND.....                          | 80                 | 85             | 90             | 95             | 100            |
|----------------------------------------------------------|--------------------|----------------|----------------|----------------|----------------|
| Hanks of slubbing in the pound...                        | $1\frac{3}{8}$     | $1\frac{3}{8}$ | $1\frac{1}{2}$ | $1\frac{1}{2}$ | $1\frac{1}{2}$ |
| Twist per inch in the slubbing ...                       | 1·407              | 1·407          | 1·469          | 1·469          | 1·469          |
| Drawing-frame sliver in decimal }<br>hank .....          | ·25                | ·25            | ·25            | ·25            | ·25            |
| Draught in the rollers .....                             | 5·5                | 5·5            | 6              | 6              | 6              |
| Diameter of the front rollers .....                      | $1\frac{1}{4}$ in. | ...            | ...            | ...            | ...            |
| Diameter of the tubes empty.....                         | $1\frac{3}{8}$ in. | ...            | ...            | ...            | ...            |
| Diameter of the bobbins when full                        | $4\frac{1}{2}$ in. | ...            | ...            | ...            | ...            |
| Laps per inch in the lift.....                           | 10·80              | 10·80          | 11·38          | 11·38          | 11·38          |
| Length of the lift .....                                 | 9in.               | ...            | ...            | ...            | ...            |
| Diameter of the spindles.....                            | $\frac{3}{4}$ in.  | ...            | ...            | ...            | ...            |
| Revolutions of the spindles per }<br>minute .....        | 545                | ...            | ...            | ...            | ...            |
| Revolutions of spindles for one }<br>of the rollers..... | 5·52               | 5·52           | 5·76           | 5·76           | 5·76           |
| Produce per spindle per week ...                         | 27·94              | 27·94          | 24·53          | 24·53          | 24·53          |
| HANKS OF YARN IN THE POUND.....                          | 110                | 120            | 130            | 140            | 150            |
| Hanks of slubbing in the pound...                        | $1\frac{1}{2}$     | $1\frac{1}{2}$ | $1\frac{1}{2}$ | $1\frac{1}{2}$ | $1\frac{1}{2}$ |
| Twist per inch in the slubbing ...                       | 1·469              | 1·469          | 1·469          | 1·469          | 1·469          |
| Drawing-frame sliver in decimal }<br>hank .....          | ·25                | ·25            | ·25            | ·25            | ·25            |
| Draught in the rollers .....                             | 6                  | 6              | 6              | 6              | 6              |
| Diameter of the front rollers .....                      | $1\frac{1}{4}$ in. | ...            | ...            | ...            | ...            |
| Diameter of the tubes empty.....                         | $1\frac{3}{8}$ in. | ...            | ...            | ...            | ...            |
| Diameter of the bobbins when full                        | $4\frac{1}{2}$ in. | ...            | ...            | ...            | ...            |
| Laps per inch in the lift.....                           | 11·38              | ...            | ...            | ...            | ...            |
| Length of the lift .....                                 | 9in.               | ...            | ...            | ...            | ...            |
| Diameter of the spindles.....                            | $\frac{3}{4}$ in.  | ...            | ...            | ...            | ...            |
| Revolutions of the spindles per }<br>minute .....        | 545                | ...            | ...            | ...            | ...            |
| Revolutions of spindles for one }<br>of the rollers..... | 5·76               | 5·76           | 5·76           | 5·76           | 5·76           |
| Produce per spindle per week ...                         | 24·53              | ...            | ...            | ...            | ...            |



## ROVING-FRAME TABLES.

*Slubbing-frame suitable for yarn of the following numbers, viz., from 160 to 250 hanks in the pound. The produce is given in pounds, and decimal parts of a pound, allowing 50 hours per week.*

| HANKS OF YARN IN THE POUND...                       | 160                 | 170            | 180            | 190            | 200            |
|-----------------------------------------------------|---------------------|----------------|----------------|----------------|----------------|
| Hanks of slubbing-roving in the pound .....         | $2\frac{1}{4}$      | $2\frac{1}{4}$ | $2\frac{1}{2}$ | $2\frac{1}{2}$ | $2\frac{5}{8}$ |
| Twist in the roving per inch .....                  | 1.80                | 1.80           | 1.89           | 1.89           | 1.94           |
| Decimal hank of drawing-frame sliver .....          | .4375               | .4375          | .5             | .5             | .5             |
| Draught in the rollers .....                        | 5.13                | 5.13           | .500           | 5.00           | 5.25           |
| Diameter of the front rollers .....                 | $1\frac{1}{8}$ in.  | ...            | ...            | ...            | ...            |
| Diameter of the tubes empty .....                   | $1\frac{3}{16}$ in. | ...            | ...            | ...            | ...            |
| Diameter of the bobbins when full .....             | $3\frac{1}{2}$ in.  | ...            | ...            | ...            | ...            |
| Laps per inch in the traverse.....                  | 13.95               | 13.95          | 14.70          | 14.10          | 15.06          |
| Length of the lift .....                            | 7 in.               | ...            | ...            | ...            | ...            |
| Diameter of the spindles.....                       | $\frac{21}{32}$ in. | ...            | ...            | ...            | ...            |
| Revolutions of the spindles per minute .....        | 750                 | ...            | ...            | ...            | ...            |
| Revolutions of spindles for one of the rollers..... | 6.36                | 6.36           | 6.66           | 6.67           | 6.85           |
| Produce per spindle per week ...                    | 18.37               | 18.37          | 15.74          | 15.74          | 84.61          |

  

| HANKS OF YARN IN THE POUND...                       | 210                 | 220            | 230   | 240   | 250            |
|-----------------------------------------------------|---------------------|----------------|-------|-------|----------------|
| Hanks of slubbing-roving in the pound .....         | $2\frac{3}{4}$      | $2\frac{3}{4}$ | 3     | 3     | $3\frac{1}{4}$ |
| Twist in the roving per inch .....                  | 1.98                | 1.98           | 2.07  | 2.07  | 2.16           |
| Decimal hank of drawing-frame sliver .....          | .5                  | .5             | .5625 | .625  | .625           |
| Draught in the rollers.....                         | 5.50                | 5.50           | 5.33  | 5.33  | 5.20           |
| Diameter of the front rollers .....                 | $1\frac{1}{8}$ in.  | ...            | ...   | ...   | ...            |
| Diameter of the tubes empty.....                    | $1\frac{3}{16}$ in. | ...            | ...   | ...   | ...            |
| Diameter of the bobbins when full .....             | $3\frac{1}{2}$ in.  | ...            | ...   | ...   | ...            |
| Laps per inch in the traverse.....                  | 15.42               | 15.42          | 16.01 | 16.01 | 16.76          |
| Length of the lift .....                            | 7 in.               | ...            | ...   | ...   | ...            |
| Diameter of the spindles.....                       | $\frac{21}{32}$ in. | ...            | ...   | ...   | ...            |
| Revolutions of the spindles per minute .....        | 750                 | ...            | ...   | ...   | ...            |
| Revolutions of spindles for one of the rollers..... | 6.99                | 6.99           | 7.31  | 7.31  | 7.63           |
| Produce per spindle per week ...                    | 13.66               | 13.66          | 11.98 | 11.98 | 10.60          |



## ROVING-FRAME TABLES.

*Slubbing-frame suitable for yarn of the following numbers, viz., from 260 to 350 hanks in the pound. The produce is given in pounds and decimal parts of a pound, allowing 50 hours per week.*

| HANKS OF YARN IN THE POUND...                        | 260                 | 270            | 280            | 290            | 300            |
|------------------------------------------------------|---------------------|----------------|----------------|----------------|----------------|
| Hanks of slubbing roving per pound .....             | $3\frac{1}{4}$      | $3\frac{3}{8}$ | $3\frac{1}{2}$ | $3\frac{1}{2}$ | $3\frac{5}{8}$ |
| Twist per inch in the roving .....                   | 2.16                | 2.20           | 2.24           | 2.24           | 2.28           |
| Decimal hank of drawing-frame sliver .....           | .625                | .625           | .6875          | .6875          | .6875          |
| Draught in the rollers .....                         | 5.20                | 5.40           | 5.09           | 5.09           | 5.27           |
| Diameter of the front rollers .....                  | $1\frac{1}{8}$ in.  | ...            | ...            | ...            | ...            |
| Diameter of the tubes empty .....                    | $1\frac{3}{16}$ in. | ...            | ...            | ...            | ...            |
| Diameter of the bobbins when full .....              | $3\frac{1}{2}$ in.  | ...            | ...            | ...            | ...            |
| Laps per inch in the lift .....                      | 16.76               | 17.08          | 17.39          | 17.39          | 17.70          |
| Length of the lift or traverse .....                 | 7 in.               | ...            | ...            | ...            | ...            |
| Diameter of the spindles .....                       | $2\frac{1}{32}$ in. | ...            | ...            | ...            | ...            |
| Revolutions of the spindles per minute .....         | 750                 | ...            | ...            | ...            | ...            |
| Revolutions of spindles for one of the rollers ..... | 7.63                | 7.77           | 7.91           | 7.91           | 8.05           |
| Produce per spindle per week ...                     | 10.60               | 10.02          | 9.490          | 9.490          | 9.02           |

| HANKS OF YARN IN THE POUND...                        | 310                 | 320            | 330   | 340   | 350            |
|------------------------------------------------------|---------------------|----------------|-------|-------|----------------|
| Hanks of slubbing roving in the pound .....          | $3\frac{3}{4}$      | $3\frac{7}{8}$ | 4     | 4     | $4\frac{1}{8}$ |
| Twist per inch in the roving .....                   | 2.31                | 2.36           | 2.40  | 2.40  | 2.43           |
| Decimal hank of drawing-frame sliver .....           | .6875               | .6875          | .75   | .75   | .8125          |
| Draught in the rollers .....                         | 5.45                | 5.62           | 5.33  | 5.33  | 5.07           |
| Diameter of the front rollers .....                  | $1\frac{1}{8}$ in.  | ...            | ...   | ...   | ...            |
| Diameter of the tubes empty .....                    | $1\frac{3}{16}$ in. | ...            | ...   | ...   | ...            |
| Diameter of the bobbins when full .....              | $3\frac{1}{2}$ in.  | ...            | ...   | ...   | ...            |
| Laps per inch in the lift .....                      | 18                  | 18.31          | 18.60 | 18.60 | 18.88          |
| Length of the lift or traverse .....                 | 7 in.               | ...            | ...   | ...   | ...            |
| Diameter of the spindles .....                       | $2\frac{1}{32}$ in. | ...            | ...   | ...   | ...            |
| Revolutions of spindles per minute .....             | 750                 | ...            | ...   | ...   | ...            |
| Revolutions of spindles for one of the rollers ..... | 8.16                | 8.34           | 8.45  | 8.45  | 8.58           |
| Produce per spindle per week .....                   | 8.589               | 8.136          | 7.750 | 7.750 | 7.422          |



## ROVING-FRAME TABLES.

*Intermediate-frame suitable for yarn of the following numbers, viz., from 22 to 40 hanks in the pound. The produce is given in pounds and decimal parts of a pound, allowing 50 hours per week.*

| HANKS OF YARN IN THE POUND...                             | 22                  | 24             | 26             | 28             | 30            |
|-----------------------------------------------------------|---------------------|----------------|----------------|----------------|---------------|
| Hanks of intermediate roving }<br>per pound .....         | $1\frac{3}{4}$      | $1\frac{3}{4}$ | $1\frac{3}{4}$ | $1\frac{7}{8}$ | 2             |
| Twist per inch in the roving .....                        | 1.54                | 1.54           | 1.54           | 1.64           | 1.69          |
| Slubbing roving put up double ...                         | $\frac{5}{8}$       | $\frac{5}{8}$  | $\frac{5}{8}$  | $\frac{3}{4}$  | $\frac{3}{4}$ |
| Draught in the rollers .....                              | 5.60                | 5.60           | 5.60           | 5              | 5.33          |
| Diameter of the front rollers .....                       | $1\frac{1}{4}$ in.  | ...            | ...            | ...            | ...           |
| Diameter of the tubes empty .....                         | $1\frac{1}{4}$ in.  | ...            | ...            | ...            | ...           |
| Diameter of the bobbins when full                         | 4in.                | ...            | ...            | ...            | ...           |
| Laps per inch in the lift .....                           | 12.30               | 12.30          | 12.30          | 12.73          | 13.15         |
| Length of the lift or traverse .....                      | 8in.                | ...            | ...            | ...            | ...           |
| Diameter of the spindles .....                            | $\frac{23}{32}$ in. | ...            | ...            | ...            | ...           |
| Revolutions of the spindles per }<br>minute .....         | 677                 | ...            | ...            | ...            | ...           |
| Revolutions of spindles for one }<br>of the rollers ..... | 6.04                | 6.04           | 6.04           | 6.44           | 6.63          |
| Produce per spindle per week ...                          | 24.91               | 24.91          | 24.91          | 21.84          | 19.87         |

  

| HANKS OF YARN IN THE POUND...                             | 32                  | 34             | 36             | 38    | 40             |
|-----------------------------------------------------------|---------------------|----------------|----------------|-------|----------------|
| Hanks of intermediate roving in }<br>the pound .....      | 2                   | $2\frac{1}{4}$ | $2\frac{1}{2}$ | 2     | $2\frac{1}{2}$ |
| Twist per inch in the roving .....                        | 1.69                | 1.80           | 1.89           | 1.89  | 1.89           |
| Slubbing roving put up double ...                         | $\frac{3}{4}$       | $\frac{7}{8}$  | 1              | 1     | 1              |
| Draught in the rollers .....                              | 5.33                | 5.14           | 5              | 5     | 5              |
| Diameter of the front rollers .....                       | $1\frac{1}{4}$ in.  | ...            | ...            | ...   | ...            |
| Diameter of the tubes empty .....                         | $1\frac{1}{4}$ in.  | ...            | ...            | ...   | ...            |
| Diameter of the bobbins when full                         | 4in.                | ...            | ...            | ...   | ...            |
| Laps per inch in the lift .....                           | 13.15               | 13.95          | 14.70          | 14.70 | 14.70          |
| Length of the lift or traverse .....                      | 8in.                | ...            | ...            | ...   | ...            |
| Diameter of the spindles .....                            | $\frac{23}{32}$ in. | ...            | ...            | ...   | ...            |
| Revolutions of the spindles per }<br>minute ... ..        | 677                 | ...            | ...            | ...   | ...            |
| Revolutions of spindles for one }<br>of the rollers ..... | 6.63                | 7.06           | 7.42           | 7.42  | 7.42           |
| Produce per spindle per week ...                          | 19.87               | 16.58          | 14.21          | 14.21 | 14.21          |



## ROVING-FRAME TABLES.

*Intermediate-frame suitable for yarn of the following numbers, viz., from 42 to 75 hanks in the pound. The produce given in pounds and decimal parts of a pound, allowing 50 hours per week.*

| HANKS OF YARN IN THE POUND...                             | 42                           | 44             | 46             | 48             | 50             |
|-----------------------------------------------------------|------------------------------|----------------|----------------|----------------|----------------|
| Hanks of intermediate roving in }<br>the pound .....      | $2\frac{1}{2}$               | $2\frac{1}{2}$ | $2\frac{1}{2}$ | $2\frac{1}{2}$ | $2\frac{3}{4}$ |
| Twist in the roving per inch .....                        | 1.89                         | 1.89           | 1.89           | 1.89           | 1.98           |
| Slubbing roving put up double ...                         | 1                            | 1              | 1              | 1              | 1              |
| Draught in the roller .....                               | 5                            | 5              | 5              | 5              | 5.50           |
| Diameter of the front rollers .....                       | $1\frac{1}{8}$ in.           | ...            | ...            | ...            | ...            |
| Diameter of the tubes empty.....                          | $1\frac{3}{16}$ in.          | ...            | ...            | ...            | ...            |
| Diameter of the bobbins full .....                        | $3\frac{1}{2}$ in.           | ...            | ...            | ...            | ...            |
| Laps per inch in the lift. ....                           | 14.70                        | 14.70          | 14.70          | 14.70          | 15.42          |
| Length of the lift or traverse.....                       | 7in.                         | ...            | ...            | ...            | ...            |
| Diameter of the spindles .....                            | $\frac{2}{3}\frac{1}{2}$ in. | ...            | ...            | ...            | ...            |
| Revolutions of the spindles per }<br>minute .....         | 750                          | ...            | ...            | ...            | ...            |
| Revolutions of spindles for one }<br>of the rollers ..... | 6.67                         | 6.67           | 6.67           | 6.67           | 6.99           |
| Produce per spindle per week.....                         | 15.74                        | ...            | ...            | ...            | 13.66          |
| HANKS OF YARN IN THE POUND...                             | 55                           | 60             | 65             | 70             | 75             |
| Hanks of intermediate roving in }<br>the pound .....      | $2\frac{3}{4}$               | 3              | $3\frac{1}{4}$ | $3\frac{1}{2}$ | $3\frac{3}{4}$ |
| Twist in the roving per inch .....                        | 1.98                         | 2.07           | 2.16           | 2.24           | 2.32           |
| Slubbing roving put up double ...                         | 1                            | 1              | $1\frac{1}{8}$ | $1\frac{1}{4}$ | $1\frac{1}{4}$ |
| Draught in the rollers.....                               | 5.50                         | 6              | 5.77           | 5.60           | 6              |
| Diameter of the front rollers .....                       | $1\frac{1}{8}$ in.           | ...            | ...            | ...            | ...            |
| Diameter of the tubes empty.....                          | $1\frac{3}{16}$ in.          | ...            | ...            | ...            | ...            |
| Diameter of the bobbins full .....                        | $3\frac{1}{2}$ in.           | ...            | ...            | ...            | ...            |
| Laps per inch in the lift.....                            | 15.42                        | 16.10          | 16.76          | 17.39          | 19.36          |
| Length of the lift or traverse.....                       | 7in.                         | ...            | ...            | ...            | ...            |
| Diameter of the spindles.....                             | $\frac{2}{3}\frac{1}{2}$ in. | ...            | ...            | ...            | ...            |
| Revolutions of the spindles per }<br>minute .....         | 750                          | ...            | ...            | ...            | ...            |
| Revolutions of spindles for one }<br>of the rollers ..... | 6.99                         | 7.31           | 7.63           | 7.91           | 8.19           |
| Produce per spindle per week ...                          | 13.66                        | 11.98          | 10.51          | 9.49           | 8.56           |



## ROVING-FRAME TABLES.

*Intermediate-frame suitable for yarn of the following numbers, viz., from 80 to 150 hanks in the pound. The produce is given in pounds and decimal parts of a pound, allowing 50 hours per week.*

| HANKS OF YARN IN THE POUND...                             | 80                  | 85             | 90             | 95             | 100            |
|-----------------------------------------------------------|---------------------|----------------|----------------|----------------|----------------|
| Hanks of intermediate roving }<br>per pound .....         | 4                   | 4              | $4\frac{1}{4}$ | $4\frac{1}{2}$ | $4\frac{1}{2}$ |
| Twist per inch in the roving .....                        | 2.40                | 2.40           | 2.47           | 2.47           | 2.54           |
| Slubbing roving put up double ...                         | $1\frac{3}{8}$      | $1\frac{3}{8}$ | $1\frac{1}{2}$ | $1\frac{1}{2}$ | $1\frac{1}{2}$ |
| Draught in the rollers.....                               | 5.81                | 5.81           | 5.66           | 5.66           | 6              |
| Diameter of the front rollers .....                       | $1\frac{1}{8}$ in.  | ...            | ...            | ...            | ...            |
| Diameter of the tubes empty.....                          | $1\frac{3}{16}$ in. | ...            | ...            | ...            | ...            |
| Diameter of the bobbins full .....                        | $3\frac{1}{2}$ in.  | ...            | ...            | ...            | ...            |
| Laps per inch in the lift.....                            | 18.60               | 18.60          | 19.16          | 19.16          | 19.72          |
| Length of the lift or traverse.....                       | 7in.                | ...            | ...            | ...            | ...            |
| Diameter of the spindles.....                             | $\frac{21}{32}$ in. | ...            | ...            | ...            | ...            |
| Revolutions of the spindles per }<br>minute.....          | 750                 | ...            | ...            | ...            | ...            |
| Revolutions of spindles for one }<br>of the rollers ..... | 8.48                | 8.48           | 8.73           | 8.73           | 8.99           |
| Produce per spindle per week ...                          | 7.939               | 7.939          | 7.224          | 7.224          | 6.510          |
| HANKS OF YARN IN THE POUND...                             | 110                 | 120            | 130            | 140            | 150            |
| Hanks of intermediate roving in }<br>the pound .....      | $4\frac{1}{2}$      | $4\frac{3}{4}$ | 5              | $5\frac{1}{2}$ | $5\frac{3}{4}$ |
| Twist per inch in the roving .....                        | 2.54                | 2.61           | 2.68           | 2.81           | 2.87           |
| Slubbing roving put up double ...                         | $1\frac{1}{2}$      | $1\frac{1}{2}$ | $1\frac{1}{2}$ | $1\frac{1}{2}$ | $1\frac{1}{2}$ |
| Draught in the rollers.....                               | 6                   | 6.33           | 6.66           | 7.33           | 7.66           |
| Diameter of the front rollers .....                       | $1\frac{1}{8}$ in.  | ...            | ...            | ...            | ...            |
| Diameter of the tubes empty.....                          | $1\frac{3}{16}$ in. | ...            | ...            | ...            | ...            |
| Diameter of the bobbins full .....                        | $3\frac{1}{2}$ in.  | ...            | ...            | ...            | ...            |
| Laps per inch in the lift.....                            | 19.72               | 20.26          | 20.79          | 21.81          | 22.30          |
| Length of the lift or traverse.....                       | 7in.                | ...            | ...            | ...            | ...            |
| Diameter of the spindles.....                             | $\frac{21}{32}$ in. | ...            | ...            | ...            | ...            |
| Revolutions of the spindles per }<br>minute.....          | 750                 | ...            | ...            | ...            | ...            |
| Revolutions of spindles for one }<br>of the rollers ..... | 8.99                | 9.22           | 9.47           | 9.93           | 10.14          |
| Produce per spindle per week.....                         | 6.510               | 6.002          | 5.552          | 4.814          | 4.508          |



## ROVING-FRAME TABLES.

*Intermediate-frame suitable for yarn of the following numbers, viz., from 160 to 250 hanks in the pound. The produce is given in pounds and decimal parts of a pound, allowing 50 hours per week.*

| HANKS OF YARN IN THE POUND...                             | 160                | 170            | 180            | 190            | 200            |
|-----------------------------------------------------------|--------------------|----------------|----------------|----------------|----------------|
| Hanks of intermediate roving }<br>in the pound.....       | $7\frac{1}{2}$     | $7\frac{3}{4}$ | 8              | $8\frac{1}{4}$ | $8\frac{1}{2}$ |
| Twist in the roving per inch.....                         | 3.28               | 3.34           | 3.39           | 3.44           | 3.49           |
| Hanks of slubbing roving put }<br>up double.....          | $2\frac{1}{4}$     | $2\frac{1}{4}$ | $2\frac{1}{2}$ | $2\frac{1}{2}$ | $2\frac{5}{8}$ |
| Draught in the rollers.....                               | 6.75               | 6.88           | 6.40           | 6.60           | 6.28           |
| Diameter of the front rollers.....                        | $1\frac{1}{8}$ in. | ...            | ...            | ...            | ...            |
| Diameter of the tubes empty.....                          | $1\frac{1}{8}$ in. | ...            | ...            | ...            | ...            |
| Diameter of the bobbins full.....                         | 3in.               | ...            | ...            | ...            | ...            |
| Laps per inch in the lift.....                            | 25.46              | 25.89          | 26.30          | 26.71          | 27.11          |
| Length of the lift or traverse.....                       | 6in.               | ...            | ...            | ...            | ...            |
| Diameter of the spindles.....                             | $\frac{5}{8}$ in.  | ...            | ...            | ...            | ...            |
| Revolutions of the spindles per }<br>minute .....         | 893                | ...            | ...            | ...            | ...            |
| Revolution of spindles for one }<br>of the rollers .....  | 11.59              | 11.80          | 11.98          | 12.15          | 12.33          |
| Produce per spindle per week ...                          | 3.601              | 3.422          | 3.266          | 3.121          | 2.986          |
| HANKS OF YARN IN THE POUND...                             | 210                | 220            | 230            | 240            | 250            |
| Hanks of intermediate roving }<br>in the pound.....       | $8\frac{3}{4}$     | 9              | $9\frac{3}{4}$ | $9\frac{1}{2}$ | $9\frac{3}{4}$ |
| Twist in the roving per inch.....                         | 3.55               | 3.60           | 3.65           | 3.69           | 3.74           |
| Hanks of slubbing roving put }<br>up double.....          | $2\frac{3}{4}$     | $2\frac{3}{4}$ | 3              | 3              | $3\frac{1}{4}$ |
| Draught in the rollers.....                               | 6.36               | 6.54           | 6.16           | 6.33           | 6              |
| Diameter of the front rollers.....                        | $1\frac{1}{8}$ in. | ...            | ...            | ...            | ...            |
| Diameter of the tubes empty.....                          | $1\frac{1}{8}$ in. | ...            | ...            | ...            | ...            |
| Diameter of the bobbins full.....                         | $2\frac{3}{4}$ in. | ...            | ...            | ...            | ...            |
| Laps per inch in the lift.....                            | 27.50              | 27.90          | 28.28          | 28.26          | 29.06          |
| Length of the lift or traverse.....                       | $5\frac{1}{2}$ in. | ...            | ...            | ...            | ...            |
| Diameter of the spindles.....                             | $\frac{5}{8}$ in.  | ...            | ...            | ...            | ...            |
| Revolutions of the spindles per }<br>minute .....         | 1,039              | ...            | ...            | ...            | ...            |
| Revolutions of spindles for one }<br>of the rollers ..... | 12.54              | 12.72          | 12.90          | 13.04          | 13.21          |
| Produce per spindle per week ...                          | 3.318              | 3.181          | 3.135          | 2.940          | 2.823          |



## ROVING-FRAME TABLES.

*Intermediate-frame suitable for yarn of the following numbers, viz., from 260 to 350 hanks in the pound. The produce is given in pounds and decimal parts of a pound, allowing 50 hours per week.*

| HANKS OF YARN IN THE POUND...                             | 260                | 270             | 280             | 290             | 300             |
|-----------------------------------------------------------|--------------------|-----------------|-----------------|-----------------|-----------------|
| Hanks of intermediate roving }<br>in the pound.....       | $10\frac{1}{4}$    | $10\frac{1}{2}$ | $10\frac{3}{4}$ | 11              | $11\frac{1}{4}$ |
| Twist in the roving per inch.....                         | 3.84               | 3.88            | 3.93            | 3.98            | 4.02            |
| Hanks of slubbing roving put }<br>up double.....          | $3\frac{1}{4}$     | $3\frac{3}{8}$  | $3\frac{1}{2}$  | $3\frac{1}{2}$  | $3\frac{5}{8}$  |
| Draught in the rollers .....                              | 6.36               | 6.21            | 6.14            | 6.28            | 6.19            |
| Diameter of the front rollers .....                       | $1\frac{1}{8}$ in. | ...             | ...             | ...             | ...             |
| Diameter of the tubes empty.....                          | $1\frac{1}{8}$ in. | ...             | ...             | ...             | ...             |
| Diameter of the bobbins full .....                        | $2\frac{3}{4}$ in. | ...             | ...             | ...             | ...             |
| Laps per inch in the lift.....                            | 29.77              | 30.13           | 30.49           | 30.83           | 31.19           |
| Length of the lift or traverse.....                       | $5\frac{1}{2}$ in. | ...             | ...             | ...             | ...             |
| Diameter of the spindles.....                             | $\frac{5}{8}$ in.  | ...             | ...             | ...             | ...             |
| Revolutions of the spindles per }<br>minute .....         | 1,039              | ...             | ...             | ...             | ...             |
| Revolutions of spindles for one }<br>of the rollers ..... | 13.57              | 13.71           | 13.88           | 14.06           | 14.20           |
| Produce per spindle per week ...                          | 2.619              | 2.503           | 2.439           | 2.354           | 2.297           |
| HANKS OF YARN IN THE POUND...                             | 310                | 320             | 330             | 340             | 350             |
| Hanks of intermediate roving }<br>in the pound.....       | $11\frac{3}{8}$    | $11\frac{5}{8}$ | 12              | $12\frac{1}{4}$ | $12\frac{1}{2}$ |
| Twist in the roving per inch.....                         | 4.04               | 4.09            | 4.15            | 4.20            | 4.24            |
| Hanks of slubbing roving put }<br>up double.....          | $3\frac{3}{4}$     | $3\frac{7}{8}$  | 4               | 4               | $4\frac{1}{8}$  |
| Draught in the rollers.....                               | 6.06               | 6               | 6               | 6.06            | 6.04            |
| Diameter of the front rollers.....                        | $1\frac{1}{8}$ in. | ...             | ...             | ...             | ...             |
| Diameter of the tubes empty.....                          | $1\frac{1}{8}$ in. | ...             | ...             | ...             | ...             |
| Diameter of the bobbins full .....                        | $2\frac{1}{2}$ in. | ...             | ...             | ...             | ...             |
| Laps per inch in the lift.....                            | 31.36              | 31.70           | 32.21           | 32.55           | 32.88           |
| Length of the lift or traverse.....                       | 5                  | ...             | ...             | ...             | ...             |
| Diameter of the spindles.....                             | $\frac{5}{8}$ in.  | ...             | ...             | ...             | ...             |
| Revolutions of the spindles per }<br>minute .....         | 1,224              | ...             | ...             | ...             | ...             |
| Revolutions of spindles for one }<br>of the rollers ..... | 14.28              | 14.45           | 14.66           | 14.84           | 14.98           |
| Produce per spindle per week ...                          | 2.642              | 2.554           | 2.438           | 2.360           | 2.291           |



## ROVING-FRAME TABLES.

*Roving-frame suitable for yarn of the following numbers, viz., from 6 to 20 hanks in the pound. The produce is given in pounds and decimal parts of a pound, allowing 51 hours per week.*

| HANKS OF YARN IN THE POUND...                             | 6                            | 7-8            | 9-10           | 11-12          | 13-14          |
|-----------------------------------------------------------|------------------------------|----------------|----------------|----------------|----------------|
| Hanks of roving in the pound ...                          | $1\frac{1}{8}$               | $1\frac{1}{4}$ | $1\frac{3}{8}$ | $1\frac{1}{2}$ | $1\frac{3}{4}$ |
| Twist in the roving per inch .....                        | 1.272                        | 1.341          | 1.407          | 1.469          | 1.546          |
| Slubbing roving put up }<br>double .....                  | $\frac{1}{2}$                | $\frac{1}{2}$  | $\frac{1}{2}$  | $\frac{1}{2}$  | $\frac{5}{8}$  |
| Draught in the rollers .....                              | 4.50                         | 5              | 5.50           | 6              | 5.60           |
| Diameter of the front rollers.....                        | $1\frac{1}{4}$ in.           | ...            | ...            | ...            | ...            |
| Diameter of the tubes empty.....                          | $1\frac{1}{4}$ in.           | ...            | ...            | ...            | ...            |
| Diameter of the bobbins full .....                        | 4in.                         | ...            | ...            | ...            | ...            |
| Length of the lift or traverse.....                       | 8in.                         | ...            | ...            | ...            | ...            |
| Laps per inch in the lift.....                            | 9.86                         | 10.39          | 10.80          | 11.38          | 12.30          |
| Diameter of the spindles.....                             | $\frac{2}{3}\frac{3}{2}$ in. | ...            | ...            | ...            | ...            |
| Revolutions of the spindles per }<br>minute .....         | 677                          | ...            | ...            | ...            | ...            |
| Revolutions of spindles for one }<br>of the rollers ..... | 4.712                        | 5.266          | 5.525          | 5.768          | 6.071          |
| Produce per spindle per week ...                          | 47.77                        | 40.86          | 35.41          | 31.08          | 25.32          |
| HANKS OF YARN IN THE POUND...                             | 15-16                        | 17             | 18             | 19             | 20             |
| Hanks of roving in the pound ...                          | 2                            | $2\frac{1}{4}$ | $2\frac{1}{4}$ | $2\frac{1}{2}$ | $2\frac{1}{2}$ |
| Twist in the roving per inch .....                        | 1.697                        | 1.800          | 1.800          | 1.897          | 1.897          |
| Slubbing roving put up }<br>double .....                  | $\frac{3}{4}$                | $\frac{3}{4}$  | $\frac{3}{4}$  | $\frac{3}{4}$  | $\frac{3}{4}$  |
| Draught in the rollers .....                              | 5.33                         | 6              | 6              | 6.66           | 6.66           |
| Diameter of the front rollers.....                        | $1\frac{1}{8}$ in.           | ...            | ...            | ...            | ...            |
| Diameter of the tubes empty.....                          | $1\frac{3}{16}$ in.          | ...            | ...            | ...            | ...            |
| Diameter of the bobbins full .....                        | $3\frac{1}{2}$ in.           | ...            | ...            | ...            | ...            |
| Length of the lift or traverse ...                        | 7in.                         | ...            | ...            | ...            | ...            |
| Laps per inch in the lift.....                            | 13.15                        | 13.95          | 13.95          | 14.70          | 14.70          |
| Diameter of the spindles .....                            | $\frac{2}{3}\frac{1}{2}$ in. | ...            | ...            | ...            | ...            |
| Revolutions of the spindles per }<br>minute .....         | 750                          | ...            | ...            | ...            | ...            |
| Revolutions of spindles for one }<br>of the rollers ..... | 5.996                        | 6.360          | 6.360          | 6.703          | 6.703          |
| Produce per spindle per week ...                          | 22.36                        | 18.80          | 18.80          | 16             | 16             |



## ROVING-FRAME TABLES.

*Roving-frame suitable for yarn of the following numbers, viz., from 22 to 40 hanks in the pound. The produce is given in pounds and decimal parts of a pound, allowing 52 hours per week.*

| HANKS OF YARN IN THE POUND...                             | 22                 | 24             | 26             | 28             | 30             |
|-----------------------------------------------------------|--------------------|----------------|----------------|----------------|----------------|
| Hanks of roving in the pound ...                          | 5                  | $5\frac{1}{2}$ | $5\frac{3}{4}$ | 6              | $6\frac{1}{2}$ |
| Twist per inch in the roving .....                        | 2.68               | 2.81           | 2.87           | 2.93           | 3.05           |
| Intermediate roving put up }<br>double .....              | $1\frac{3}{4}$     | $1\frac{3}{4}$ | $1\frac{3}{4}$ | $1\frac{7}{8}$ | 2              |
| Draught in the rollers.....                               | 5.71               | 6.25           | 6.57           | 6.40           | 6.50           |
| Diameter of the front rollers.....                        | $1\frac{1}{8}$ in. | ...            | ...            | ...            | ...            |
| Diameter of the tubes empty.....                          | $1\frac{1}{8}$ in. | ...            | ...            | ...            | ...            |
| Diameter of the bobbins full .....                        | $2\frac{3}{4}$ in. | ...            | ...            | ...            | ...            |
| Laps per inch in the lift.....                            | 20.79              | 21.81          | 22.30          | 22.78          | 23.71          |
| Length of the lift or traverse.....                       | 6in.               | ...            | ...            | ...            | ...            |
| Diameter of the spindles.....                             | $\frac{5}{8}$ in.  | ...            | ...            | ...            | ...            |
| Revolutions of the spindles per }<br>minute .....         | 893                | ...            | ...            | ...            | ...            |
| Revolutions of spindles for one }<br>of the rollers ..... | 9.47               | 9.93           | 10.14          | 10.35          | 10.77          |
| Produce per spindle per week.....                         | 6.875              | 5.961          | 5.583          | 5.24           | 4.64           |

  

| HANKS OF YARN IN THE POUND...                             | 32                 | 34             | 36             | 38             | 40             |
|-----------------------------------------------------------|--------------------|----------------|----------------|----------------|----------------|
| Hanks of roving in the pound ...                          | $6\frac{3}{4}$     | 7              | $7\frac{1}{2}$ | $7\frac{1}{2}$ | 8              |
| Twist per inch in the roving .....                        | 3.11               | 3.17           | 3.28           | 3.28           | 3.39           |
| Intermediate roving put up }<br>double .....              | 2                  | $2\frac{1}{4}$ | $2\frac{1}{2}$ | $2\frac{1}{2}$ | $2\frac{1}{2}$ |
| Draught in the rollers.....                               | 6.75               | 6.22           | 6              | 6              | 6.40           |
| Diameter of the front rollers.....                        | $1\frac{1}{8}$ in. | ...            | ...            | ...            | ...            |
| Diameter of the tubes empty.....                          | $1\frac{1}{8}$ in. | ...            | ...            | ...            | ...            |
| Diameter of the bobbins full .....                        | $2\frac{3}{4}$ in. | ...            | ...            | ...            | ...            |
| Length of the lift or traverse.....                       | 6in.               | ...            | ...            | ...            | ...            |
| Laps per inch in the lift.....                            | 23.48              | 24.60          | 25.46          | 25.46          | 26.30          |
| Diameter of the spindles.....                             | $\frac{5}{8}$ in.  | ...            | ...            | ...            | ...            |
| Revolutions of the spindles per }<br>minute .....         | 893                | ...            | ...            | ...            | ...            |
| Revolutions of spindles for one }<br>of the rollers ..... | 10.99              | 11.20          | 11.59          | 11.59          | 11.98          |
| Produce per spindle per week.....                         | 4.388              | 4.152          | 3.745          | 3.745          | 3.397          |



## ROVING-FRAME TABLES.

*Roving-frame suitable for yarn of the following numbers, viz., from 42 to 75 hanks in the pound. The produce is given in pounds and decimal parts of a pound, allowing 50 hours per week.*

| HANKS OF YARN IN THE POUND...                        | 42                 | 44             | 46             | 48             | 50             |
|------------------------------------------------------|--------------------|----------------|----------------|----------------|----------------|
| Hanks of roving in the pound ...                     | 8                  | $8\frac{1}{2}$ | 9              | 9              | $9\frac{1}{2}$ |
| Twist in the roving per inch .....                   | 3.39               | 3.49           | 3.60           | 3.60           | 3.69           |
| Intermediate-roving put up double                    | $2\frac{1}{2}$     | $2\frac{1}{2}$ | $2\frac{1}{2}$ | $2\frac{1}{2}$ | $2\frac{3}{4}$ |
| Draught in the rollers .....                         | 6.40               | 6.80           | 7.60           | 7.60           | 6.90           |
| Diameter of the front rollers .....                  | $1\frac{1}{8}$ in. | ...            | ...            | ...            | ...            |
| Diameter of the tubes empty .....                    | $1\frac{1}{8}$ in. | ...            | ...            | ...            | ...            |
| Diameter of the bobbins full .....                   | $2\frac{3}{4}$ in. | ...            | ...            | ...            | ...            |
| Laps per inch in the lift .....                      | 26.30              | 27.11          | 27.90          | 27.90          | 28.66          |
| Length of the lift or traverse ...                   | $5\frac{1}{2}$ in. | ...            | ...            | ...            | ...            |
| Diameter of the spindles .....                       | $\frac{5}{8}$ in.  | ...            | ...            | ...            | ...            |
| Revolutions of the spindles per minute .....         | 1,039              | ...            | ...            | ...            | ...            |
| Revolutions of spindles for one of the rollers ..... | 11.98              | 12.33          | 12.72          | 12.72          | 13.04          |
| Produce per spindle per week ...                     | 3.952              | 3.591          | 3.308          | 3.308          | 3.058          |
| HANKS OF YARN IN THE POUND...                        | 55                 | 60             | 65             | 70             | 75             |
| Hanks of roving in the pound ...                     | $10\frac{1}{2}$    | 11             | 12             | 13             | 14             |
| Twist in the roving per inch .....                   | 3.88               | 3.97           | 4.15           | 4.43           | 4.48           |
| Intermediate roving put up double                    | $2\frac{3}{4}$     | 3              | $3\frac{1}{4}$ | $3\frac{1}{2}$ | $3\frac{3}{4}$ |
| Draught in the rollers .....                         | 7.63               | 7.33           | 7.40           | 7.57           | 7.46           |
| Diameter of the front rollers .....                  | $1\frac{1}{8}$ in. | ...            | ...            | ...            | ...            |
| Diameter of the tubes empty .....                    | $1\frac{1}{8}$ in. | ...            | ...            | ...            | ...            |
| Diameter of the bobbins full .....                   | $2\frac{1}{2}$ in. | ...            | ...            | ...            | ...            |
| Laps per inch in the lift .....                      | 30.13              | 30.83          | 32.21          | 33.53          | 34.79          |
| Length of the lift or traverse ...                   | 5 in.              | ...            | ...            | ...            | ...            |
| Diameter of the spindles .....                       | $\frac{5}{8}$ in.  | ...            | ...            | ...            | ...            |
| Revolutions of the spindles per minute .....         | 1,224              | ...            | ...            | ...            | ...            |
| Revolutions of spindles for one of the rollers ..... | 13.71              | 14.03          | 14.66          | 15.26          | 15.83          |
| Produce per spindle per week ...                     | 3.052              | 2.891          | 2.535          | 2.248          | 2.013          |



## ROVING-FRAME TABLES.

*Roving-frame suitable for yarn of the following numbers, viz., from 80 to 150 hanks in the pound. The produce is given in pounds and decimal parts of a pound, allowing 50 hours per week.*

| HANKS OF YARN IN THE POUND...                             | 80                 | 85    | 90             | 95             | 100            |
|-----------------------------------------------------------|--------------------|-------|----------------|----------------|----------------|
| Hanks of roving in the pound ...                          | 15                 | 16    | 17             | 18             | 19             |
| Twist in the roving per inch .....                        | 4.647              | 4.800 | 4.947          | 5.091          | 5.230          |
| Intermediate roving put up double                         | 4                  | 4     | $4\frac{1}{4}$ | $4\frac{1}{4}$ | $4\frac{1}{2}$ |
| Draught in the rollers .....                              | 7.50               | 8     | 8              | 8.47           | 8.44           |
| Diameter of the front rollers .....                       | $1\frac{1}{8}$ in. | ...   | ...            | ...            | ...            |
| Diameter of the tubes empty .....                         | $1\frac{1}{8}$ in. | ...   | ...            | ...            | ...            |
| Diameter of the bobbins full .....                        | $2\frac{1}{2}$ in. | ...   | ...            | ...            | ...            |
| Laps per inch in the lift .....                           | 36.01              | 37.20 | 38.34          | 39.45          | 40.53          |
| Length of the lift .....                                  | 5in.               | ...   | ...            | ...            | ...            |
| Diameter of the spindles .....                            | $\frac{5}{8}$ in.  | ...   | ...            | ...            | ...            |
| Revolutions of the spindles per }<br>minute .....         | 1,224              | ...   | ...            | ...            | ...            |
| Revolutions of spindles for one }<br>of the rollers ..... | 16.42              | 16.96 | 17.48          | 17.99          | 18.48          |
| Produce per spindle per week ...                          | 1.811              | 1.669 | 1.516          | 1.378          | 1.270          |

  

| HANKS OF YARN IN THE POUND...                             | 110                | 120            | 130   | 140            | 150            |
|-----------------------------------------------------------|--------------------|----------------|-------|----------------|----------------|
| Hanks of roving in the pound ...                          | 20                 | 21             | 22    | 24             | 25             |
| Twist in the roving per inch .....                        | 5.366              | 5.499          | 5.628 | 5.878          | 6              |
| Intermediate roving put up double                         | $4\frac{1}{2}$     | $4\frac{3}{4}$ | 5     | $5\frac{1}{2}$ | $5\frac{3}{4}$ |
| Draught in the rollers .....                              | 8.88               | 8.84           | 8.80  | 8.72           | 8.69           |
| Diameter of the front rollers .....                       | $1\frac{1}{8}$ in. | ...            | ...   | ...            | ...            |
| Diameter of the tubes empty .....                         | $1\frac{1}{8}$ in. | ...            | ...   | ...            | ...            |
| Diameter of the bobbins full .....                        | $2\frac{1}{4}$ in. | ...            | ...   | ...            | ...            |
| Laps per inch in the lift .....                           | 41.59              | 42.61          | 43.62 | 45.56          | 46.50          |
| Length of the lift .....                                  | $4\frac{1}{2}$ in. | ...            | ...   | ...            | ...            |
| Diameter of the spindles .....                            | $\frac{5}{8}$ in.  | ...            | ...   | ...            | ...            |
| Revolutions of the spindles per }<br>minute .....         | 1,615              | ...            | ...   | ...            | ...            |
| Revolutions of spindles for one }<br>of the rollers ..... | 18.96              | 19.43          | 19.89 | 20.77          | 21.20          |
| Produce per spindle per week ...                          | 1.555              | 1.442          | 1.345 | 1.181          | 1.110          |



## ROVING-FRAME TABLES.

*Roving-frame suitable for yarn of the following numbers, viz., from 160 to 250 hanks in the pound. The produce is given in decimal parts of a pound, allowing 53 hours per week.*

| HANKS OF YARN IN THE POUND...                             | 160   | 179   | 180   | 190   | 200   |
|-----------------------------------------------------------|-------|-------|-------|-------|-------|
| Hanks of roving in the pound ...                          | 27    | 28    | 29    | 30    | 31    |
| Twist in the roving per inch .....                        | 6.23  | 6.34  | 6.46  | 6.57  | 6.68  |
| Hanks of intermediate roving }<br>put up double .....     | 7½    | 7¾    | 8.    | 8¼    | 8½    |
| Draught in the rollers.....                               | 7.20  | 7.22  | 7.25  | 7.27  | 7.29  |
| Diameter of the front rollers .....                       | 1½in. | ...   | ...   | ...   | ...   |
| Diameter of the tubes empty .....                         | 1½in. | ...   | ...   | ...   | ...   |
| Diameter of the bobbins when full                         | 2¼in. | ...   | ...   | ...   | ...   |
| Laps per inch in the lift .....                           | 48.32 | 49.21 | 50.08 | 50.93 | 51.78 |
| Length of the lift .....                                  | 4in.  | ...   | ...   | ...   | ...   |
| Diameter of the spindles .....                            | ⅝in.  | ...   | ...   | ...   | ...   |
| Revolutions of the spindles per }<br>minute .....         | 1,647 | ...   | ...   | ...   | ...   |
| Revolutions of spindles for one }<br>of the rollers ..... | 22.01 | 22.40 | 22.83 | 23.22 | 23.60 |
| Produce per spindle per week.....                         | 1.029 | .9756 | .9244 | .8787 | .8363 |

  

| HANKS OF YARN IN THE POUND..                              | 210   | 220   | 230   | 240   | 250   |
|-----------------------------------------------------------|-------|-------|-------|-------|-------|
| Hanks of roving in the pound ...                          | 32    | 33    | 34    | 35    | 36    |
| Twist in the roving per inch .....                        | 6.78  | 6.89  | 6.99  | 7.09  | 7.20  |
| Hanks of intermediate roving }<br>put up double .....     | 8¾    | 9.    | 9¼    | 9½    | 9¾    |
| Draught in the rollers.....                               | 7.38  | 7.33  | 7.35  | 7.34  | 7.38  |
| Diameter of the front rollers .....                       | 1½in. | ...   | ...   | ...   | ...   |
| Diameter of the tubes empty .....                         | 1½in. | ...   | ...   | ...   | ...   |
| Diameter of the bobbins when full                         | 2¼in. | ...   | ...   | ...   | ...   |
| Laps per inch in the lift .....                           | 52.60 | 53.42 | 54.22 | 55.01 | 55.80 |
| Length of the lift .....                                  | 4in.  | ...   | ...   | ...   | ...   |
| Diameter of the spindles .....                            | ⅝in.  | ...   | ...   | ...   | ...   |
| Revolutions of the spindles per }<br>minute .....         | 1,647 | ...   | ...   | ...   | ...   |
| Revolutions of spindles for one }<br>of the rollers ..... | 23.96 | 24.35 | 24.70 | 25.05 | 25.44 |
| Produce per spindle per week ...                          | .7982 | .7617 | .7287 | .6979 | .6681 |



## ROVING-FRAME TABLES.

*Roving-frame suitable for yarn of the following numbers, viz., from 260 to 350 hanks in the pound. The produce is given in decimal parts of a pound, allowing 53 hours per week.*

| HANKS OF YARN IN THE POUND...                             | 260                 | 270              | 280              | 290              | 300              |
|-----------------------------------------------------------|---------------------|------------------|------------------|------------------|------------------|
| Hanks of roving in the pound ...                          | 37                  | 38               | 39               | 40               | 41               |
| Twist in the roving per inch .....                        | 7·299               | 7·397            | 7·493            | 7·589            | 7·683            |
| Hanks of intermediate roving }<br>put up double .....     | 10 $\frac{1}{4}$    | 10 $\frac{1}{2}$ | 10 $\frac{3}{4}$ | 11               | 11 $\frac{1}{4}$ |
| Draught in the rollers .....                              | 7·22                | 7·23             | 7·25             | 7·27             | 7·28             |
| Diameter of the front rollers .....                       | 1 $\frac{1}{8}$ in. | ...              | ...              | ...              | ...              |
| Diameter of the tubes empty.....                          | 1 $\frac{1}{8}$ in. | ...              | ...              | ...              | ...              |
| Diameter of the bobbins when full                         | 2 $\frac{1}{8}$ in. | ...              | ...              | ...              | ...              |
| Laps per inch in the lift.....                            | 56·56               | 57·32            | 57·92            | 58·81            | 59·54            |
| Length of the lift or traverse.....                       | 3 $\frac{1}{2}$ in. | ...              | ...              | ...              | ...              |
| Diameter of the spindles.....                             | $\frac{5}{8}$ in.   | ...              | ...              | ...              | ...              |
| Revolutions of the spindles per }<br>minute .....         | 1,959               | ...              | ...              | ...              | ...              |
| Revolutions of spindles for one }<br>of the rollers ..... | 25·79               | 26·14            | 26·48            | 26·82            | 27·15            |
| Produce per spindle per week.....                         | ·7628               | ·7327            | ·7005            | ·6786            | ·6539            |
| HANKS OF YARN IN THE POUND...                             | 310                 | 320              | 330              | 340              | 350              |
| Hanks of roving in the pound ...                          | 42                  | 43               | 44               | 45               | 46               |
| Twist in the roving per inch .....                        | 7·776               | 7·868            | 7·960            | 8·050            | 8·138            |
| Hanks of intermediate roving }<br>put up double .....     | 11 $\frac{3}{8}$    | 11 $\frac{5}{8}$ | 12               | 12 $\frac{1}{4}$ | 12 $\frac{1}{2}$ |
| Draught in the rollers .....                              | 7·38                | 7·39             | 7·33             | 7·34             | 7·36             |
| Diameter of the front rollers .....                       | 1 $\frac{1}{8}$ in. | ...              | ...              | ...              | ...              |
| Diameter of the tubes empty.....                          | 1 $\frac{1}{8}$ in. | ...              | ...              | ...              | ...              |
| Diameter of the bobbins when full                         | 2 $\frac{1}{8}$ in. | ...              | ...              | ...              | ...              |
| Laps per inch in the lift.....                            | 60·27               | 60·98            | 61·68            | 62·53            | 63·07            |
| Length of the lift or traverse... ..                      | 3 $\frac{1}{2}$ in. | ...              | ...              | ...              | ...              |
| Diameter of the spindles.....                             | $\frac{5}{8}$ in.   | ...              | ...              | ...              | ...              |
| Revolutions of the spindles per }<br>minute .....         | 1,959               | ...              | ...              | ...              | ...              |
| Revolutions of spindles for one }<br>of the rollers ..... | 27·46               | 27·81            | 28·13            | 28·45            | 28·73            |
| Produce per spindle per week.....                         | ·6307               | ·6089            | ·5881            | ·5686            | ·5503            |



## T A B L E

Showing the twist per inch, and the laps per inch on the bobbins,  
according with the size of the roving.

| Hank<br>Roving. | Twist<br>per inch. | Laps<br>per inch<br>in the<br>Lift. | Hank<br>Roving. | Twist<br>per inch. | Laps<br>per inch<br>in the<br>Lift. |
|-----------------|--------------------|-------------------------------------|-----------------|--------------------|-------------------------------------|
| $1\frac{1}{2}$  | ·849               | 6·576                               | $4\frac{3}{4}$  | 2·615              | 20·268                              |
| $1\frac{5}{8}$  | ·949               | 7·358                               | $4\frac{7}{8}$  | 2·649              | 20·533                              |
| $1\frac{3}{4}$  | 1·039              | 8·052                               | 5               | 2·683              | 20·793                              |
| $1\frac{7}{8}$  | 1·122              | 8·699                               | $5\frac{1}{8}$  | 2·716              | 21·053                              |
| 1               | 1·200              | 9·300                               | $5\frac{1}{4}$  | 2·749              | 21·308                              |
| $1\frac{1}{8}$  | 1·272              | 9·863                               | $5\frac{3}{8}$  | 2·782              | 21·561                              |
| $1\frac{1}{4}$  | 1·341              | 10·397                              | $5\frac{1}{2}$  | 2·814              | 21·810                              |
| $1\frac{3}{8}$  | 1·407              | 10·805                              | $5\frac{5}{8}$  | 2·846              | 22·057                              |
| $1\frac{1}{2}$  | 1·469              | 11·389                              | $5\frac{3}{4}$  | 2·877              | 22·300                              |
| $1\frac{5}{8}$  | 1·529              | 11·849                              | $5\frac{7}{8}$  | 2·908              | 22·541                              |
| $1\frac{3}{4}$  | 1·587              | 12·302                              | 6               | 2·939              | 22·780                              |
| $1\frac{7}{8}$  | 1·643              | 12·734                              | $6\frac{1}{8}$  | 2·969              | 23·009                              |
| 2               | 1·697              | 13·152                              | $6\frac{1}{4}$  | 3·000              | 23·250                              |
| $2\frac{1}{8}$  | 1·749              | 13·556                              | $6\frac{3}{8}$  | 3·029              | 23·480                              |
| $2\frac{1}{4}$  | 1·800              | 13·950                              | $6\frac{1}{2}$  | 3·059              | 23·710                              |
| $2\frac{3}{8}$  | 1·849              | 14·331                              | $6\frac{5}{8}$  | 3·088              | 23·938                              |
| $2\frac{1}{2}$  | 1·897              | 14·704                              | $6\frac{3}{4}$  | 3·117              | 24·161                              |
| $2\frac{5}{8}$  | 1·944              | 15·067                              | $6\frac{7}{8}$  | 3·146              | 24·384                              |
| $2\frac{3}{4}$  | 1·989              | 15·422                              | 7               | 3·175              | 24·605                              |
| $2\frac{7}{8}$  | 2·034              | 15·768                              | $7\frac{1}{8}$  | 3·203              | 24·823                              |
| 3               | 2·078              | 16·107                              | $7\frac{1}{4}$  | 3·231              | 25·040                              |
| $3\frac{1}{8}$  | 2·121              | 16·439                              | $7\frac{3}{8}$  | 3·258              | 25·255                              |
| $3\frac{1}{4}$  | 2·163              | 16·765                              | $7\frac{1}{2}$  | 3·286              | 25·468                              |
| $3\frac{3}{8}$  | 2·204              | 17·085                              | $7\frac{5}{8}$  | 3·313              | 25·679                              |
| $3\frac{1}{2}$  | 2·244              | 17·391                              | $7\frac{3}{4}$  | 3·340              | 25·890                              |
| $3\frac{5}{8}$  | 2·284              | 17·701                              | $7\frac{7}{8}$  | 3·367              | 26·107                              |
| $3\frac{3}{4}$  | 2·323              | 18·003                              | 8               | 3·394              | 26·304                              |
| $3\frac{7}{8}$  | 2·362              | 18·313                              | $8\frac{1}{8}$  | 3·420              | 26·519                              |
| 4               | 2·400              | 18·600                              | $8\frac{1}{4}$  | 3·447              | 26·717                              |
| $4\frac{1}{8}$  | 2·437              | 18·886                              | $8\frac{3}{8}$  | 3·472              | 26·913                              |
| $4\frac{1}{4}$  | 2·473              | 19·165                              | $8\frac{1}{2}$  | 3·498              | 27·113                              |
| $4\frac{3}{8}$  | 2·509              | 19·444                              | $8\frac{5}{8}$  | 3·524              | 27·312                              |
| $4\frac{1}{2}$  | 2·545              | 19·723                              | $8\frac{3}{4}$  | 3·549              | 27·509                              |
| $4\frac{5}{8}$  | 2·580              | 20·000                              | $8\frac{7}{8}$  | 3·574              | 27·705                              |



## T A B L E

Showing the twist per inch, and the laps per inch on the bobbins,  
according with the size of the roving.

| Hank<br>Roving.  | Twist<br>per inch. | Laps<br>per inch<br>in the<br>Lift. | Hank<br>Roving. | Twist<br>per inch. | Laps<br>per inch<br>in the<br>Lift. |
|------------------|--------------------|-------------------------------------|-----------------|--------------------|-------------------------------------|
| 9                | 3.600              | 27.900                              | 17              | 4.948              | 38.344                              |
| 9 $\frac{1}{8}$  | 3.624              | 28.092                              | 18              | 5.091              | 39.456                              |
| 9 $\frac{1}{4}$  | 3.649              | 28.284                              | 19              | 5.230              | 40.537                              |
| 9 $\frac{3}{8}$  | 3.674              | 28.475                              | 20              | 5.366              | 41.590                              |
| 9 $\frac{1}{2}$  | 3.698              | 28.664                              | 21              | 5.499              | 42.617                              |
| 9 $\frac{5}{8}$  | 3.723              | 28.852                              | 22              | 5.628              | 43.620                              |
| 9 $\frac{3}{4}$  | 3.746              | 29.039                              | 23              | 5.754              | 44.601                              |
| 9 $\frac{7}{8}$  | 3.770              | 29.224                              | 24              | 5.878              | 45.560                              |
| 10               | 3.794              | 29.409                              | 25              | 6.000              | 46.500                              |
| 10 $\frac{1}{8}$ | 3.818              | 29.592                              | 26              | 6.118              | 47.320                              |
| 10 $\frac{1}{4}$ | 3.841              | 29.774                              | 27              | 6.235              | 48.324                              |
| 10 $\frac{3}{8}$ | 3.865              | 29.945                              | 28              | 6.349              | 49.211                              |
| 10 $\frac{1}{2}$ | 3.888              | 30.135                              | 29              | 6.462              | 50.082                              |
| 10 $\frac{5}{8}$ | 3.911              | 30.314                              | 30              | 6.572              | 50.938                              |
| 10 $\frac{3}{4}$ | 3.934              | 30.492                              | 31              | 6.681              | 51.780                              |
| 10 $\frac{7}{8}$ | 3.957              | 30.663                              | 32              | 6.788              | 52.608                              |
| 11               | 3.979              | 30.834                              | 33              | 6.893              | 53.424                              |
| 11 $\frac{1}{8}$ | 4.002              | 31.019                              | 34              | 6.997              | 54.227                              |
| 11 $\frac{1}{4}$ | 4.024              | 31.193                              | 35              | 7.099              | 55.019                              |
| 11 $\frac{3}{8}$ | 4.047              | 31.365                              | 36              | 7.200              | 55.800                              |
| 11 $\frac{1}{2}$ | 4.069              | 31.537                              | 37              | 7.299              | 56.569                              |
| 11 $\frac{5}{8}$ | 4.091              | 31.706                              | 38              | 7.397              | 57.329                              |
| 11 $\frac{3}{4}$ | 4.113              | 31.878                              | 39              | 7.493              | 57.923                              |
| 11 $\frac{7}{8}$ | 4.135              | 32.047                              | 40              | 7.589              | 58.814                              |
| 12               | 4.156              | 32.216                              | 41              | 7.683              | 59.549                              |
| 12 $\frac{1}{8}$ | 4.178              | 32.382                              | 42              | 7.776              | 60.270                              |
| 12 $\frac{1}{4}$ | 4.200              | 32.550                              | 43              | 7.868              | 60.984                              |
| 12 $\frac{3}{8}$ | 4.221              | 32.716                              | 44              | 7.959              | 61.688                              |
| 12 $\frac{1}{2}$ | 4.242              | 32.885                              | 45              | 8.049              | 62.536                              |
| 12 $\frac{5}{8}$ | 4.284              | 33.208                              | 46              | 8.138              | 63.075                              |
| 13               | 4.326              | 33.536                              | 47              | 8.227              | 63.764                              |
| 14               | 4.489              | 34.797                              | 48              | 8.313              | 64.433                              |
| 15               | 4.647              | 36.017                              | 49              | 8.400              | 65.100                              |
| 16               | 4.800              | 37.200                              | 50              | 8.484              | 65.751                              |



## MULE SPINNING.

As there are four or five different kinds of yarn required for as many different purposes, it is well to consider how to spin these different yarns to the best advantage. The following are the principal kinds most generally in use, viz., yarn suitable for calicoes woven on power-looms, yarn with an extra quantity of twist for strong heavy cloth, such yarn as is generally spun upon the throstle-frame and goes under the name of water twist. Weft yarn, such as used for filling up the warp in the process of weaving. Yarn for doubling, used for making superior warps for what are called "unions," the weft or filling of which may be woollen or worsted; such yarn is likewise used for making into thread or sewing cotton of different numbers of folds according to the quality or purposes to which it may be applied. Yarn for the purpose of making into thread should be of the very best quality. Hosiery yarn is chiefly used in looped fabrics, such as stockings, undershirts, and drawers. This yarn requires to be very clean and level, and should be spun with care, as it is very soft on account of having but little twist in it. Perhaps hosiery yarn might be spun to most advantage on roving-frames, though spinning it in this manner might appear to cost more than upon self-acting mules. However, there is one great advantage in favour of spinning it upon roving-frames, and that is, when it is spun it is already wound upon tubes, and when these tubes are filled with yarn they are called bobbins, and bobbins thus made are much firmer built than can possibly be when the yarn has to be wound from the cop to the spool, so that there is a saving in the expense of winding in favour of spinning hosiery yarn on roving-frames, and there is no doubt about it being the better method of spinning hosiery yarn than spinning it upon self-acting mules, as the roving-frame can be regulated to take up the yarn as if it were roving, whereas self-acting mules are subject to stretch it in places if the minder is not very careful in regulating the winding.

There is another advantage in favour of the roving-frame. From the compactness of the winding-on of the yarn the bobbins are more safe from damage in transportation by railway than spools are, which are subject to flush or shell off; and when this is the case the contents of the spool may be considered as waste. Though much has been said in favour of hosiery yarn being spun upon roving-frames, it cannot be denied that self-acting mules will turn out a far greater quantity of yarn in the finer counts than roving-frames can on account of the difference in the speed of the spindles; but, as respects the doubling of the hosiery yarn,



there is no machine in existence equal to the roving-frame for that purpose, where so small a quantity of twist is required as one turn per inch, or even less than that, though that may be considered small enough. It is only put in to keep the threads in contact with each other.

### GOOD YARN FOR CALICOES.

In spinning yarn for calico warps why is it necessary to put so much doubling in it?

Doubling and drawing out again finer and finer is done for the purpose of straightening out the fibres and making the yarn more even and uniform. Much doubling and drawing has a good effect in cleaning the thread, which may be noticed at every operation it goes through by the dirt that is left on the roller beams. Were it not so, this dirt would be a source of much annoyance and waste by causing the yarn to break when there was no other cause to account for the breakage, except the yarn be short of twist while the spindles are receding from the rollers. We see the effect, but how can we account for the cause? To a reflective mind the cause is very apparent. Suppose a small particle of shell or husk is contained in the body of the yarn, and has been too firmly attached to be lost in passing through the different operations, we may imagine the yarn to be so soft or short of twist that there is not sufficient power to cause the twist to go beyond the obstruction, consequently it has a similar effect as if the yarn was held between the finger and thumb to prevent the twist from going any farther, so that the remaining portion is too soft to sustain its own weight. As a proof of this, it is only necessary to take up the coil from the point of the spindle and examine the broken end.

But it may be asked, why not put more twist in the yarn to give it sufficient strength to overcome so small an obstruction? That is often done when the cotton is dirty and short in the staple, and sometimes it is necessary to lessen the draught between the rollers and spindles, for short-stapled cotton will not allow of as much gaining of the carriages as cotton of a longer staple. The yarn should receive two-thirds of its twist while the carriage is receding from the rollers. This is done to keep the yarn sufficiently soft or slack of twist, to allow it to give a draught to the gaining of the carriage. If the full quantity of twist is put into the yarn as it is delivered by the rollers, that draught or gain could not be effected in consequence of the twist holding the thread too firmly together to admit of the fibres giving way to any draught without breaking



the yarn. The draught between the rollers and spindles, or what is called the gaining of the carriage, is a relic of Hargreaves's system of spinning before drawing by fluted rollers was brought into practice by Richard Arkwright. The combination of the two systems of Hargreaves and Arkwright by Samuel Crompton has brought us to the system of spinning cotton yarn upon mules far superior to either or both for producing any quality of yarn, from the coarsest to the finest, suitable for manufacturing into any kinds of goods, from the coarsest domestic cloth to the finest robes that the caprice of fashion may need for the embellishment of the persons and homes of the wealthier portion of the inhabitants of all nations. Crompton's improvement, although it was a great advance in the art of spinning cotton, should not detract from but rather add to the merits of Hargreaves and Arkwright, for both their inventions were really original, while his invention was a combination of the two by the introduction of the travelling carriage which bears the name of mule. Had it not been for the two original ideas perhaps the name of Crompton would never have been known to the public; but the original ideas must have taken firm root in his mind, which forced him into deep study, and by his energy and persevering industry his efforts were crowned with that success which surpassed his own expectations, for it not only found employment for thousands but has been the means of reducing the art of cotton spinning to a system equally if not surpassing military precision, from which has sprung up one of our principal sources of wealth. But let us resume our inquiry why a draught is necessary between the rollers and spindles? Is there any such draught in spinning upon the throstle-frame? No, of course not—nor can there be; but a shrinkage is required according to the quantity of twist put into the yarn, which is something like ten per cent; the same would take place upon mules if the same quantity of twist was put into the yarn as it is delivered from the rollers, such as is the case in throstle spinning, so the draught in the rollers would have to be very considerably increased in comparison to what is necessary when the yarn is drawn by the gaining of the carriage; but, notwithstanding this, water twist can be spun cheaper and with less waste in the yarn, and with far greater economy in oil and power upon self-acting, mules. It is possible to spin hard twisted yarn upon mules and yet retain the principle of a draught between the rollers and spindles and the second stretch after the rollers stop by moving the carriage slowly towards the rollers as the extra twist may require it, so as to save any breakage in the yarn. This would improve water twist as far as can be reasonably expected, and produce what is called super extra twist. As the second question is, I hope, disposed of let us attend to the first question. Why



is a draught necessary between the rollers and spindles? In throstle spinning we cannot imagine any method by which a draught between the rollers and spindles can be accomplished, but in mule spinning the case is different—provision can be made for a draught between the rollers and spindles by the gaining of the carriage, in allowing only two-thirds of twist to be put into the yarn while the draught is taking place during the receding of the carriage from the rollers. This draught is considered necessary for producing first-rate yarn. Although much doubling improves the yarn, there are still inequalities to be found that cannot be removed by any other means than by the gaining of the carriage and stretching at the head of the draw after the rollers stop. It is effected in this manner: As the carriage leaves the rollers the twist distributes itself along the yarn, but not equally so. It enters first into the weakest or the least resisting part of the yarn, while the gaining of the carriage is operating in drawing out the thicker and softer twisted portion until the rollers stop; the second stretch then commences and makes as near perfect as possible what the gaining of the carriage has been unable to complete. The second stretch should end when the yarn has received four-fifths of its twist, so that the yarn will be sufficiently soft to allow it to give to the draught of the second stretch without breaking the yarn. I hope this explanation is sufficiently clear to the understanding of any person who may be desirous of gaining a thorough knowledge of the science of cotton spinning. Weft or filling is spun much in the same manner as warp yarn but with less twist. There is much diversity of opinion with respect to the number of doublings put in weft yarn. Some spinners will put as few in as possible, while some will put in a medium quantity, and others again will give the same number of doublings to weft as is requisite for twist. Much depends upon the quality of the cloth or other goods to which it may be applied, but it would be the best policy to put as much doubling into weft as would produce a level yarn without increasing the cost much. This can be done by a proper arrangement of the machinery without any alteration in wages. This need not be further discussed here, as it will be found properly arranged in the tables adapted for weft. Yarn for doubling, used for superior warps and making thread, is spun in every respect exactly like twist or warp yarn, with one exception, and that is, it has much less twist put in it than warp yarn. Suppose the twist for all kinds be represented in the following proportion, viz., extra twist 16, twist 15, weft 13, for doubling 11, hosiery yarn 10. This is considered to be a correct proportion. The twist necessary in doubling and making thread is found in the same manner as for twist or warp yarn—that is, by multiplying the square root of counts or numbers of yarn by 3.75. In this way, supposing



yarn when doubled to be 49's, the square root would be  $7 \times 3.75 = 26.25$  twists per inch. Then, again, what counts of yarn would be required? Supposing 5 per cent to be allowed for shrinkage, we have  $49 + 2.45 = 51.45 \times 2 = 103$  hanks per pound; so that by this formula we must have single yarn of 103 hanks in the pound to produce a double thread of 47 hanks in the pound, and *vice versa*. Extra twist is required to enable the yarn to withstand the extra wear and tear of the healds and reeds in weaving heavy cloth; super extra yarn is required for the same purpose, but for cloth of a superior quality.



DIMENSIONS OF SPINDLES.

*The distance apart, lengths and diameters of spindles and their bearings, adapted to suit different kinds of yarn, according to the coarseness or fineness.*

The distance and length of the spindles is given in inches and parts of an inch. The diameters of the points, and the top and bottom bearings with the length of the bearings, is given in inch and decimal parts of an inch. The bottom bearings should be parallel for an inch, or the centrifugal force will draw the oil out of the step. The length of the top and bottom bearing is independent of the countersink in the brasses.

| Hanks of Yarn per Pound. | Distance of the Spindles. | Length of the Spindles. | Length above Top Bearing. | Length of Top Taper. | Diameter of Top Bearing. | Diameter of Bottom Bearing. | Length of Top Bearing. | Length of Bottom Bearing. | Diameter of the points of the Spindles. |
|--------------------------|---------------------------|-------------------------|---------------------------|----------------------|--------------------------|-----------------------------|------------------------|---------------------------|-----------------------------------------|
| Up to 8.....             | 1 $\frac{3}{4}$           | 17 $\frac{1}{2}$        | 8 $\frac{1}{4}$           | 7 $\frac{1}{2}$      | .33                      | .27                         | 1.200                  | .54                       | .135                                    |
| " 25.....                | 1 $\frac{1}{2}$           | 17                      | 8                         | 7 $\frac{1}{4}$      | .32                      | .26                         | 1.155                  | .52                       | .125                                    |
| " 50.....                | 1 $\frac{3}{8}$           | 16 $\frac{1}{2}$        | 7 $\frac{3}{4}$           | 7                    | .31                      | .25                         | 1.120                  | .50                       | .115                                    |
| " 100.....               | 1 $\frac{1}{4}$           | 15 $\frac{1}{2}$        | 7 $\frac{1}{4}$           | 6 $\frac{1}{2}$      | .30                      | .24                         | 1.050                  | .48                       | .105                                    |
| " 150.....               | 1 $\frac{1}{4}$           | 15                      | 7                         | 6 $\frac{1}{4}$      | .28                      | .22                         | 1.000                  | .44                       | .100                                    |
| " 200.....               | 1 $\frac{1}{4}$           | 14 $\frac{1}{2}$        | 6 $\frac{3}{4}$           | 6                    | .28                      | .22                         | 1.000                  | .44                       | .095                                    |
| " 300.....               | 1 $\frac{1}{8}$           | 14                      | 6 $\frac{1}{2}$           | 5 $\frac{3}{4}$      | .28                      | .22                         | 1.000                  | .44                       | .090                                    |
| For Shuttle Cops         | 1 $\frac{1}{8}$           | 14                      | 6 $\frac{1}{2}$           | 5 $\frac{3}{4}$      | .28                      | .22                         | 1.000                  | .44                       | .125                                    |



## A TABLE

Showing the square root of the numbers or counts from 1 to 350 hanks in the pound, with the twist per inch for different kinds of yarn.

| Counts<br>or<br>num-<br>bers. | Square<br>root. | Extra<br>mule<br>twist. | Mule<br>twist. | Weft<br>twist. | Twist<br>for<br>doub-<br>ling. | Hosiery<br>yarn. |
|-------------------------------|-----------------|-------------------------|----------------|----------------|--------------------------------|------------------|
| 1                             | 1.0000          | 4.00                    | 3.75           | 3.25           | 2.75                           | 2.50             |
| 2                             | 1.4142          | 5.65                    | 5.30           | 4.60           | 3.88                           | 3.53             |
| 3                             | 1.7320          | 6.92                    | 6.49           | 5.62           | 4.76                           | 4.33             |
| 4                             | 2.0000          | 8.00                    | 7.50           | 6.50           | 5.50                           | 5.00             |
| 5                             | 2.2360          | 8.94                    | 8.37           | 7.26           | 6.14                           | 5.59             |
| 6                             | 2.4494          | 9.79                    | 9.18           | 7.96           | 6.73                           | 6.12             |
| 7                             | 2.6457          | 10.58                   | 9.92           | 8.59           | 7.27                           | 6.61             |
| 8                             | 2.8284          | 11.31                   | 10.50          | 9.19           | 7.77                           | 7.07             |
| 9                             | 3.0000          | 12.00                   | 11.25          | 9.75           | 8.25                           | 7.50             |
| 10                            | 3.1622          | 12.64                   | 11.85          | 10.27          | 8.79                           | 7.90             |
| 11                            | 3.3166          | 13.26                   | 12.43          | 10.77          | 9.12                           | 8.29             |
| 12                            | 3.4641          | 13.85                   | 12.99          | 11.25          | 9.52                           | 8.66             |
| 13                            | 3.6055          | 14.42                   | 13.55          | 11.71          | 9.91                           | 9.01             |
| 14                            | 3.7416          | 14.96                   | 14.03          | 12.16          | 10.28                          | 9.35             |
| 15                            | 3.8729          | 15.49                   | 14.52          | 12.48          | 10.65                          | 9.68             |
| 16                            | 4.0000          | 16.00                   | 15.00          | 13.00          | 11.00                          | 10.00            |
| 17                            | 4.1231          | 16.49                   | 15.46          | 13.40          | 11.33                          | 10.30            |
| 18                            | 4.2426          | 16.97                   | 15.90          | 13.78          | 11.66                          | 10.60            |
| 19                            | 4.3588          | 17.43                   | 16.34          | 14.16          | 11.98                          | 10.89            |
| 20                            | 4.4721          | 17.88                   | 16.77          | 14.53          | 12.29                          | 11.18            |
| 21                            | 4.5825          | 18.33                   | 17.18          | 14.89          | 12.60                          | ...              |
| 22                            | 4.6904          | 18.76                   | 17.58          | 15.24          | 12.89                          | ...              |
| 23                            | 4.7958          | 19.18                   | 17.98          | 15.58          | 13.18                          | ...              |
| 24                            | 4.8989          | 19.59                   | 18.37          | 15.92          | 13.47                          | ...              |
| 25                            | 5.0000          | 20.00                   | 18.75          | 16.25          | 13.75                          | ...              |
| 26                            | 5.0990          | 20.39                   | 19.11          | 16.57          | 14.02                          | ...              |
| 27                            | 5.1961          | 20.78                   | 19.48          | 16.88          | 14.28                          | ...              |
| 28                            | 5.2915          | 21.16                   | 19.84          | 17.19          | 14.55                          | ...              |
| 29                            | 5.3851          | 21.54                   | 20.19          | 17.49          | 14.80                          | ...              |
| 30                            | 5.4772          | 21.90                   | 20.53          | 17.80          | 15.06                          | ...              |



## CONTINUATION OF THE TWIST TABLE.

| Counts<br>or<br>num-<br>bers. | Square<br>root. | Extra<br>mule<br>twist. | Mule<br>twist. | Weft<br>twist. | Twist<br>for<br>doubling. |
|-------------------------------|-----------------|-------------------------|----------------|----------------|---------------------------|
| 31                            | 5.5677          | 22.27                   | 19.77          | 18.09          | 15.31                     |
| 32                            | 5.6568          | 22.62                   | 21.21          | 18.38          | 15.55                     |
| 33                            | 5.7745          | 23.09                   | 21.64          | 18.75          | 15.87                     |
| 34                            | 5.8309          | 23.32                   | 21.86          | 18.95          | 16.03                     |
| 35                            | 5.9160          | 23.66                   | 22.18          | 19.22          | 16.27                     |
| 36                            | 6.0000          | 24.00                   | 22.50          | 19.50          | 16.50                     |
| 37                            | 6.0827          | 24.33                   | 22.81          | 19.76          | 16.72                     |
| 38                            | 6.1644          | 24.65                   | 23.11          | 20.03          | 16.95                     |
| 39                            | 6.2449          | 24.98                   | 23.41          | 20.29          | 17.17                     |
| 40                            | 6.3245          | 25.29                   | 23.71          | 20.55          | 17.39                     |
| 41                            | 6.4031          | 25.61                   | 24.01          | 20.81          | 17.60                     |
| 42                            | 6.4807          | 25.92                   | 24.30          | 21.05          | 17.82                     |
| 43                            | 6.5574          | 26.22                   | 24.59          | 21.31          | 18.03                     |
| 44                            | 6.6332          | 26.53                   | 24.87          | 21.55          | 18.24                     |
| 45                            | 6.7082          | 26.83                   | 25.15          | 21.80          | 18.44                     |
| 46                            | 6.7823          | 27.12                   | 25.43          | 22.04          | 18.65                     |
| 47                            | 6.8556          | 27.42                   | 25.70          | 22.28          | 18.85                     |
| 48                            | 6.9282          | 27.71                   | 25.98          | 22.51          | 18.95                     |
| 49                            | 7.0000          | 28.00                   | 26.25          | 22.75          | 19.25                     |
| 50                            | 7.0710          | 28.28                   | 26.51          | 22.98          | 19.44                     |
| 51                            | 7.1414          | 28.56                   | 26.78          | 23.20          | 19.63                     |
| 52                            | 7.2111          | 28.84                   | 27.04          | 23.43          | 19.83                     |
| 53                            | 7.2807          | 29.12                   | 27.30          | 23.66          | 20.02                     |
| 54                            | 7.3484          | 29.39                   | 27.55          | 23.88          | 20.20                     |
| 55                            | 7.4161          | 29.66                   | 27.81          | 24.10          | 20.39                     |
| 56                            | 7.4833          | 29.93                   | 28.06          | 24.32          | 20.57                     |
| 57                            | 7.5498          | 30.20                   | 28.31          | 24.53          | 20.76                     |
| 58                            | 7.6157          | 30.46                   | 28.55          | 24.75          | 20.94                     |
| 59                            | 7.6811          | 30.72                   | 28.80          | 24.96          | 21.14                     |
| 60                            | 7.7459          | 30.98                   | 29.04          | 25.17          | 21.30                     |
| 61                            | 7.8102          | 31.24                   | 29.28          | 25.38          | 21.47                     |
| 62                            | 7.8740          | 31.49                   | 29.52          | 25.59          | 21.65                     |



## CONTINUATION OF THE TWIST TABLE.

| Counts<br>or<br>num-<br>bers. | Square<br>root. | Extra<br>mule<br>twist. | Mule<br>twist. | Weft<br>twist. | Twist<br>for<br>doubling. |
|-------------------------------|-----------------|-------------------------|----------------|----------------|---------------------------|
| 63                            | 7.9372          | 31.748                  | 29.764         | 25.795         | 21.827                    |
| 64                            | 8.0000          | 32.000                  | 30.000         | 26.000         | 22.000                    |
| 65                            | 8.0622          | 32.248                  | 30.233         | 26.202         | 22.171                    |
| 66                            | 8.1240          | 32.496                  | 30.465         | 26.403         | 22.341                    |
| 67                            | 8.1853          | 32.741                  | 30.693         | 26.602         | 22.509                    |
| 68                            | 8.2462          | 32.984                  | 30.923         | 26.800         | 22.677                    |
| 69                            | 8.3066          | 33.226                  | 31.149         | 26.996         | 22.843                    |
| 70                            | 8.3666          | 33.466                  | 31.374         | 27.191         | 23.008                    |
| 71                            | 8.4261          | 33.704                  | 31.597         | 27.384         | 23.171                    |
| 72                            | 8.4852          | 33.940                  | 31.819         | 27.576         | 23.334                    |
| 73                            | 8.5440          | 34.176                  | 32.030         | 27.768         | 23.486                    |
| 74                            | 8.6023          | 34.409                  | 32.258         | 27.957         | 23.656                    |
| 75                            | 8.6602          | 34.640                  | 32.475         | 28.145         | 23.815                    |
| 76                            | 8.7177          | 34.870                  | 32.691         | 28.332         | 23.973                    |
| 77                            | 8.7749          | 35.099                  | 32.905         | 28.518         | 24.130                    |
| 78                            | 8.8317          | 35.326                  | 33.178         | 28.603         | 24.287                    |
| 79                            | 8.8881          | 35.552                  | 33.330         | 28.886         | 24.442                    |
| 80                            | 8.2442          | 35.776                  | 33.540         | 29.068         | 24.596                    |
| 81                            | 9.0000          | 36.000                  | 33.750         | 29.250         | 24.750                    |
| 82                            | 9.0553          | 36.221                  | 33.957         | 29.429         | 24.902                    |
| 83                            | 9.1104          | 36.441                  | 34.164         | 29.608         | 25.053                    |
| 84                            | 9.1651          | 36.660                  | 34.369         | 29.786         | 25.204                    |
| 85                            | 9.2195          | 36.878                  | 34.573         | 29.963         | 25.353                    |
| 86                            | 9.2736          | 37.094                  | 34.776         | 30.139         | 25.502                    |
| 87                            | 9.3273          | 37.289                  | 34.977         | 30.313         | 25.650                    |
| 88                            | 9.3808          | 37.523                  | 35.178         | 30.487         | 25.797                    |
| 89                            | 9.4339          | 37.735                  | 35.377         | 30.660         | 25.943                    |
| 90                            | 9.4868          | 37.947                  | 35.475         | 30.832         | 26.088                    |
| 91                            | 9.5393          | 38.157                  | 35.772         | 31.002         | 26.233                    |
| 92                            | 9.5916          | 38.366                  | 35.968         | 31.172         | 26.376                    |
| 93                            | 9.6436          | 38.574                  | 36.163         | 31.341         | 26.519                    |
| 94                            | 9.6953          | 38.781                  | 36.357         | 31.509         | 26.662                    |



## CONTINUATION OF THE TWIST TABLE.

| Counts<br>or<br>num-<br>bers. | Square<br>root. | Extra<br>mule<br>twist. | Mule<br>twist. | Weft<br>twist. | Twist<br>for<br>doubling. |
|-------------------------------|-----------------|-------------------------|----------------|----------------|---------------------------|
| 95                            | 9.7467          | 38.986                  | 36.550         | 31.676         | 26.803                    |
| 96                            | 9.7979          | 39.191                  | 36.742         | 31.842         | 26.944                    |
| 97                            | 9.8488          | 39.395                  | 36.933         | 32.008         | 27.084                    |
| 98                            | 9.8994          | 39.597                  | 37.112         | 32.173         | 27.223                    |
| 99                            | 9.9498          | 39.799                  | 37.311         | 32.336         | 27.361                    |
| 100                           | 10.0000         | 40.000                  | 37.500         | 32.500         | 27.500                    |
| 101                           | 10.0498         | 40.199                  | 37.686         | 32.661         | 27.636                    |
| 102                           | 10.0995         | 40.398                  | 37.873         | 32.823         | 27.777                    |
| 103                           | 10.1488         | 40.595                  | 38.058         | 32.983         | 27.909                    |
| 104                           | 10.1980         | 40.792                  | 38.242         | 33.143         | 28.044                    |
| 105                           | 10.2469         | 40.987                  | 38.425         | 33.302         | 28.179                    |
| 106                           | 10.2956         | 41.182                  | 38.608         | 33.460         | 28.313                    |
| 107                           | 10.3440         | 41.376                  | 38.790         | 33.618         | 28.446                    |
| 108                           | 10.3923         | 41.569                  | 38.971         | 33.774         | 28.578                    |
| 109                           | 10.4403         | 41.761                  | 39.151         | 33.930         | 28.710                    |
| 110                           | 10.4880         | 41.952                  | 39.330         | 34.086         | 28.842                    |
| 111                           | 10.5356         | 42.142                  | 39.508         | 34.240         | 28.973                    |
| 112                           | 10.5830         | 42.332                  | 39.686         | 34.394         | 29.103                    |
| 113                           | 10.6301         | 42.520                  | 39.862         | 34.547         | 29.232                    |
| 114                           | 10.6770         | 42.708                  | 40.038         | 34.700         | 29.361                    |
| 115                           | 10.7238         | 42.895                  | 40.214         | 34.852         | 29.490                    |
| 116                           | 10.7703         | 43.081                  | 40.388         | 35.003         | 29.618                    |
| 117                           | 10.8166         | 43.266                  | 40.562         | 35.153         | 29.745                    |
| 118                           | 10.8627         | 43.450                  | 40.734         | 35.303         | 29.872                    |
| 119                           | 10.9087         | 43.634                  | 40.907         | 35.452         | 29.999                    |
| 120                           | 10.9544         | 43.817                  | 41.079         | 35.601         | 30.124                    |
| 121                           | 11.0000         | 44.000                  | 41.250         | 35.750         | 30.250                    |
| 122                           | 11.0453         | 44.181                  | 41.419         | 35.897         | 30.374                    |
| 123                           | 11.0905         | 44.362                  | 41.589         | 36.044         | 30.498                    |
| 124                           | 11.1355         | 44.542                  | 41.778         | 36.190         | 30.642                    |
| 125                           | 11.1803         | 44.721                  | 41.926         | 36.335         | 30.745                    |
| 126                           | 11.2249         | 44.899                  | 42.093         | 36.480         | 30.868                    |



## CONTINUATION OF THE TWIST TABLE.

| Counts<br>or<br>num-<br>bers. | Square<br>root. | Extra<br>mule<br>twist. | Mule<br>twist. | Weft<br>twist. | Twist<br>for<br>doubling. |
|-------------------------------|-----------------|-------------------------|----------------|----------------|---------------------------|
| 127                           | 11.2694         | 45.077                  | 42.260         | 36.625         | 30.990                    |
| 128                           | 11.3137         | 45.254                  | 42.426         | 36.779         | 31.112                    |
| 129                           | 11.3578         | 45.431                  | 42.591         | 36.912         | 31.234                    |
| 130                           | 11.4017         | 45.606                  | 42.756         | 37.055         | 31.353                    |
| 131                           | 11.4455         | 45.782                  | 42.920         | 37.197         | 31.475                    |
| 132                           | 11.4891         | 45.956                  | 43.084         | 37.339         | 31.594                    |
| 133                           | 11.5325         | 46.130                  | 43.246         | 37.480         | 31.714                    |
| 134                           | 11.5758         | 46.303                  | 43.409         | 37.622         | 31.833                    |
| 135                           | 11.6189         | 46.475                  | 43.570         | 37.760         | 31.951                    |
| 136                           | 11.6619         | 46.647                  | 43.732         | 37.901         | 32.070                    |
| 137                           | 11.7046         | 46.818                  | 43.892         | 38.040         | 32.187                    |
| 138                           | 11.7473         | 46.982                  | 44.052         | 38.178         | 32.305                    |
| 139                           | 11.7898         | 47.159                  | 44.211         | 38.316         | 32.421                    |
| 140                           | 11.8321         | 47.328                  | 44.370         | 38.474         | 32.549                    |
| 141                           | 11.8743         | 47.497                  | 44.528         | 38.591         | 32.654                    |
| 142                           | 11.9163         | 47.665                  | 44.686         | 38.727         | 32.769                    |
| 143                           | 11.9582         | 47.832                  | 44.842         | 38.864         | 32.885                    |
| 144                           | 12.0000         | 48.000                  | 45.000         | 39.000         | 33.000                    |
| 145                           | 12.0415         | 48.166                  | 45.155         | 39.134         | 33.114                    |
| 146                           | 12.0830         | 48.332                  | 45.301         | 39.269         | 33.228                    |
| 147                           | 12.1243         | 48.497                  | 45.466         | 39.403         | 33.341                    |
| 148                           | 12.1655         | 48.662                  | 45.620         | 39.537         | 33.455                    |
| 149                           | 12.2065         | 48.826                  | 45.744         | 39.671         | 33.567                    |
| 150                           | 12.2474         | 48.989                  | 45.927         | 39.804         | 33.680                    |
| 151                           | 12.2882         | 49.152                  | 46.080         | 39.936         | 33.792                    |
| 152                           | 12.3288         | 49.315                  | 46.233         | 40.068         | 33.904                    |
| 153                           | 12.3693         | 49.477                  | 46.384         | 40.199         | 34.015                    |
| 154                           | 12.4096         | 49.638                  | 46.536         | 40.331         | 34.126                    |
| 155                           | 12.4498         | 49.799                  | 46.686         | 40.461         | 34.237                    |
| 156                           | 12.4899         | 49.959                  | 46.837         | 40.592         | 34.347                    |
| 157                           | 12.5299         | 50.119                  | 46.987         | 40.722         | 34.457                    |
| 158                           | 12.5698         | 50.279                  | 47.136         | 40.851         | 34.567                    |



## CONTINUATION OF THE TWIST TABLE.

| Counts<br>or<br>num-<br>bers. | Square<br>root. | Extra<br>mule<br>twist. | Mule<br>twist. | Weft<br>twist. | Twist<br>for<br>doubling. |
|-------------------------------|-----------------|-------------------------|----------------|----------------|---------------------------|
| 159                           | 12.6095         | 50.438                  | 47.285         | 40.980         | 34.676                    |
| 160                           | 12.6491         | 50.596                  | 47.434         | 41.109         | 34.785                    |
| 161                           | 12.6885         | 50.754                  | 47.581         | 41.237         | 34.892                    |
| 162                           | 12.7279         | 50.911                  | 47.729         | 41.365         | 35.001                    |
| 163                           | 12.7671         | 51.068                  | 47.876         | 41.493         | 35.109                    |
| 164                           | 12.8062         | 51.224                  | 48.023         | 41.620         | 35.217                    |
| 165                           | 12.8452         | 51.380                  | 48.179         | 41.746         | 35.324                    |
| 166                           | 12.8840         | 51.536                  | 48.315         | 41.873         | 35.431                    |
| 167                           | 12.9228         | 51.691                  | 48.460         | 41.999         | 35.537                    |
| 168                           | 12.9614         | 51.845                  | 48.605         | 42.124         | 35.643                    |
| 169                           | 13.0000         | 52.000                  | 48.750         | 42.250         | 35.750                    |
| 170                           | 13.0384         | 52.153                  | 48.893         | 42.374         | 35.855                    |
| 171                           | 13.0766         | 52.306                  | 49.037         | 42.598         | 35.960                    |
| 172                           | 13.1148         | 52.459                  | 49.180         | 42.623         | 36.065                    |
| 173                           | 13.1529         | 52.611                  | 49.323         | 42.746         | 36.170                    |
| 174                           | 13.1909         | 52.763                  | 49.465         | 42.870         | 36.274                    |
| 175                           | 13.2287         | 52.914                  | 49.607         | 42.993         | 36.378                    |
| 176                           | 13.2664         | 53.065                  | 49.749         | 43.015         | 36.482                    |
| 177                           | 13.3041         | 53.216                  | 49.890         | 43.238         | 36.586                    |
| 178                           | 13.3416         | 53.366                  | 50.020         | 43.360         | 36.688                    |
| 179                           | 13.3790         | 53.516                  | 50.171         | 43.481         | 36.792                    |
| 180                           | 13.4164         | 53.664                  | 50.311         | 43.609         | 36.895                    |
| 181                           | 13.4536         | 53.814                  | 50.451         | 43.733         | 36.997                    |
| 182                           | 13.4907         | 53.962                  | 50.590         | 43.844         | 37.099                    |
| 183                           | 13.5277         | 54.110                  | 50.728         | 43.963         | 37.201                    |
| 184                           | 13.5646         | 54.258                  | 50.867         | 44.085         | 37.302                    |
| 185                           | 13.6014         | 54.405                  | 51.004         | 44.204         | 37.403                    |
| 186                           | 13.6381         | 54.552                  | 51.141         | 44.323         | 37.504                    |
| 187                           | 13.6747         | 54.698                  | 51.280         | 44.442         | 37.605                    |
| 188                           | 13.7113         | 54.845                  | 51.417         | 44.561         | 37.706                    |
| 189                           | 13.7477         | 54.990                  | 51.553         | 44.680         | 37.806                    |
| 190                           | 13.7840         | 55.136                  | 51.690         | 44.798         | 37.906                    |



## CONTINUATION OF THE TWIST TABLE.

| Counts<br>or<br>num-<br>bers. | Square<br>root. | Extra<br>mule<br>twist. | Mule<br>twist. | Weft<br>twist. | Twist<br>for<br>doubling. |
|-------------------------------|-----------------|-------------------------|----------------|----------------|---------------------------|
| 191                           | 13.8202         | 55.280                  | 51.825         | 44.915         | 38.005                    |
| 192                           | 13.8564         | 55.425                  | 51.961         | 45.033         | 38.105                    |
| 193                           | 13.8924         | 55.569                  | 52.096         | 45.152         | 38.204                    |
| 194                           | 13.9283         | 55.713                  | 52.231         | 45.267         | 38.292                    |
| 195                           | 13.9642         | 55.856                  | 52.364         | 45.383         | 38.402                    |
| 196                           | 14.0000         | 56.000                  | 52.500         | 45.500         | 38.500                    |
| 197                           | 14.0356         | 56.142                  | 52.633         | 45.615         | 38.598                    |
| 198                           | 14.0712         | 56.284                  | 52.767         | 45.731         | 38.695                    |
| 199                           | 14.1067         | 56.426                  | 52.900         | 45.846         | 38.793                    |
| 200                           | 14.1421         | 56.568                  | 53.032         | 45.961         | 38.890                    |
| 201                           | 14.1774         | 56.709                  | 53.165         | 46.076         | 38.987                    |
| 202                           | 14.2126         | 56.850                  | 53.297         | 46.191         | 39.084                    |
| 203                           | 14.2478         | 56.991                  | 53.429         | 46.305         | 39.181                    |
| 204                           | 14.2828         | 57.131                  | 53.560         | 46.419         | 39.297                    |
| 205                           | 14.3178         | 57.271                  | 53.691         | 46.532         | 39.474                    |
| 206                           | 14.3527         | 57.410                  | 53.822         | 46.646         | 39.470                    |
| 207                           | 14.3874         | 57.549                  | 53.952         | 46.750         | 39.565                    |
| 208                           | 14.4222         | 57.688                  | 54.083         | 46.872         | 39.661                    |
| 209                           | 14.4568         | 57.827                  | 54.212         | 46.984         | 39.756                    |
| 210                           | 14.4913         | 57.965                  | 54.342         | 47.096         | 39.851                    |
| 211                           | 14.5258         | 58.103                  | 54.471         | 47.208         | 39.946                    |
| 212                           | 14.5602         | 58.240                  | 54.580         | 47.320         | 40.020                    |
| 213                           | 14.5945         | 58.378                  | 54.729         | 47.432         | 40.134                    |
| 214                           | 14.6287         | 58.514                  | 54.857         | 47.543         | 40.229                    |
| 215                           | 14.6628         | 58.651                  | 54.985         | 47.654         | 40.322                    |
| 216                           | 14.6969         | 58.787                  | 55.113         | 47.765         | 40.416                    |
| 217                           | 14.7309         | 58.923                  | 55.240         | 47.875         | 40.510                    |
| 218                           | 14.7648         | 59.059                  | 55.368         | 47.985         | 40.603                    |
| 219                           | 14.7986         | 59.194                  | 55.494         | 48.095         | 40.696                    |
| 220                           | 14.8323         | 59.329                  | 55.619         | 48.205         | 40.788                    |
| 221                           | 14.8660         | 59.464                  | 55.745         | 48.314         | 40.879                    |
| 222                           | 14.8996         | 59.598                  | 55.872         | 48.413         | 40.984                    |



## CONTINUATION OF THE TWIST TABLE.

| Counts<br>or<br>num-<br>bers. | Square<br>root. | Extra<br>mule<br>twist. | Mule<br>twist. | Weft<br>twist. | Twist<br>for<br>doubling. |
|-------------------------------|-----------------|-------------------------|----------------|----------------|---------------------------|
| 223                           | 14.9331         | 59.732                  | 55.999         | 48.532         | 41.066                    |
| 224                           | 14.9666         | 59.866                  | 56.124         | 48.641         | 41.158                    |
| 225                           | 15.0000         | 60.000                  | 56.250         | 48.750         | 41.250                    |
| 226                           | 15.0332         | 60.132                  | 56.374         | 48.858         | 41.341                    |
| 227                           | 15.0665         | 60.266                  | 56.499         | 48.966         | 41.432                    |
| 228                           | 15.0996         | 60.398                  | 56.623         | 49.073         | 41.524                    |
| 229                           | 15.1327         | 60.530                  | 56.747         | 49.181         | 41.615                    |
| 230                           | 15.1657         | 60.662                  | 56.871         | 49.288         | 41.705                    |
| 231                           | 15.1986         | 60.794                  | 56.994         | 49.395         | 41.796                    |
| 232                           | 15.2315         | 60.926                  | 57.018         | 49.502         | 41.886                    |
| 233                           | 15.2643         | 61.057                  | 57.241         | 49.609         | 41.976                    |
| 234                           | 15.2970         | 61.188                  | 57.363         | 49.715         | 42.066                    |
| 235                           | 15.3297         | 61.318                  | 57.486         | 49.821         | 42.156                    |
| 236                           | 15.3622         | 61.448                  | 57.548         | 49.927         | 42.246                    |
| 237                           | 15.3948         | 61.579                  | 57.730         | 50.032         | 42.335                    |
| 238                           | 15.4272         | 61.708                  | 57.852         | 50.138         | 42.424                    |
| 239                           | 15.4596         | 61.838                  | 57.973         | 50.243         | 42.514                    |
| 240                           | 15.4919         | 61.967                  | 58.094         | 50.348         | 42.602                    |
| 241                           | 15.5241         | 62.096                  | 58.215         | 50.453         | 42.691                    |
| 242                           | 15.5563         | 62.225                  | 58.336         | 50.565         | 42.779                    |
| 243                           | 15.5884         | 62.353                  | 58.456         | 50.662         | 42.868                    |
| 244                           | 15.6204         | 62.481                  | 58.576         | 50.766         | 42.956                    |
| 245                           | 15.6524         | 62.609                  | 58.696         | 50.870         | 43.043                    |
| 246                           | 15.6843         | 62.737                  | 58.816         | 50.974         | 43.121                    |
| 247                           | 15.7162         | 62.864                  | 58.935         | 51.077         | 43.219                    |
| 248                           | 15.7480         | 62.992                  | 59.055         | 51.181         | 43.307                    |
| 249                           | 15.7797         | 63.118                  | 59.173         | 51.284         | 43.394                    |
| 250                           | 15.8113         | 63.245                  | 59.292         | 51.386         | 43.481                    |
| 251                           | 15.8429         | 63.371                  | 59.410         | 51.489         | 43.568                    |
| 252                           | 15.8745         | 63.498                  | 59.529         | 51.592         | 43.654                    |
| 253                           | 15.9059         | 63.623                  | 59.647         | 51.694         | 43.741                    |
| 254                           | 15.9373         | 63.749                  | 59.764         | 51.795         | 43.827                    |



## CONTINUATION OF THE TWIST TABLE.

| Counts<br>or<br>num-<br>bers. | Square<br>root. | Extra<br>mule<br>twist. | Mule<br>twist. | Weft<br>twist. | Twist<br>for<br>doubling. |
|-------------------------------|-----------------|-------------------------|----------------|----------------|---------------------------|
| 255                           | 15.9687         | 63.874                  | 59.882         | 51.898         | 43.914                    |
| 256                           | 16.0000         | 64.000                  | 60.000         | 52.000         | 44.000                    |
| 257                           | 16.0312         | 64.124                  | 60.117         | 52.101         | 44.085                    |
| 258                           | 16.0623         | 64.249                  | 60.233         | 52.202         | 44.171                    |
| 259                           | 16.0934         | 64.373                  | 60.350         | 52.303         | 44.256                    |
| 260                           | 16.1245         | 64.498                  | 60.467         | 52.404         | 44.342                    |
| 261                           | 16.1554         | 64.621                  | 60.582         | 52.505         | 44.427                    |
| 262                           | 16.1864         | 64.745                  | 60.699         | 52.605         | 44.512                    |
| 263                           | 16.2172         | 64.868                  | 60.814         | 52.705         | 44.597                    |
| 264                           | 16.2480         | 64.992                  | 60.930         | 52.806         | 44.682                    |
| 265                           | 16.2788         | 65.115                  | 61.045         | 52.906         | 44.766                    |
| 266                           | 16.3095         | 65.238                  | 61.160         | 53.005         | 44.851                    |
| 267                           | 16.3401         | 65.360                  | 61.275         | 53.105         | 44.935                    |
| 268                           | 16.3707         | 65.482                  | 61.390         | 53.204         | 45.019                    |
| 269                           | 16.4012         | 65.604                  | 61.504         | 53.303         | 45.103                    |
| 270                           | 16.4316         | 65.726                  | 61.618         | 53.402         | 45.187                    |
| 271                           | 16.4620         | 65.848                  | 61.732         | 53.501         | 45.270                    |
| 272                           | 16.4924         | 65.969                  | 61.846         | 53.600         | 45.354                    |
| 273                           | 16.5227         | 66.090                  | 61.960         | 53.698         | 45.437                    |
| 274                           | 16.5529         | 66.211                  | 62.073         | 53.797         | 45.520                    |
| 275                           | 16.5831         | 66.332                  | 62.186         | 53.895         | 45.603                    |
| 276                           | 16.6132         | 66.452                  | 62.299         | 53.993         | 45.686                    |
| 277                           | 16.6433         | 66.573                  | 62.412         | 54.090         | 45.769                    |
| 278                           | 16.6733         | 66.693                  | 62.524         | 54.188         | 45.851                    |
| 279                           | 16.7032         | 66.812                  | 62.637         | 54.285         | 45.933                    |
| 280                           | 16.7332         | 66.932                  | 62.749         | 54.383         | 46.016                    |
| 281                           | 16.7630         | 67.052                  | 62.861         | 54.479         | 46.098                    |
| 282                           | 16.7928         | 67.171                  | 62.973         | 54.576         | 46.180                    |
| 283                           | 16.8226         | 67.290                  | 63.084         | 54.673         | 46.262                    |
| 284                           | 16.8522         | 67.408                  | 63.195         | 54.769         | 46.343                    |
| 285                           | 16.8819         | 67.527                  | 63.307         | 54.866         | 46.425                    |
| 286                           | 16.9115         | 67.646                  | 63.418         | 54.962         | 46.506                    |



## CONTINUATION OF THE TWIST TABLE.

| Counts<br>or<br>num-<br>bers. | Square<br>root. | Extra<br>mule<br>twist. | Mule<br>twist. | Weft<br>twist. | Twist<br>for<br>doubling. |
|-------------------------------|-----------------|-------------------------|----------------|----------------|---------------------------|
| 287                           | 16.9410         | 67.764                  | 63.528         | 55.058         | 46.587                    |
| 288                           | 16.9705         | 67.881                  | 63.638         | 55.153         | 46.668                    |
| 289                           | 17.0000         | 68.000                  | 63.750         | 55.250         | 46.750                    |
| 290                           | 17.0293         | 68.117                  | 63.859         | 55.345         | 46.830                    |
| 291                           | 17.0587         | 68.234                  | 63.970         | 55.440         | 46.911                    |
| 292                           | 17.0880         | 68.352                  | 64.080         | 55.536         | 46.992                    |
| 293                           | 17.1172         | 68.468                  | 64.189         | 55.631         | 47.072                    |
| 294                           | 17.1464         | 68.585                  | 64.299         | 55.726         | 47.152                    |
| 295                           | 17.1755         | 68.702                  | 64.407         | 55.820         | 47.232                    |
| 296                           | 17.2046         | 68.818                  | 64.517         | 55.915         | 47.312                    |
| 297                           | 17.2336         | 68.934                  | 64.626         | 56.009         | 47.392                    |
| 298                           | 17.2626         | 69.050                  | 64.734         | 56.103         | 47.472                    |
| 299                           | 17.2916         | 69.166                  | 64.843         | 56.197         | 47.553                    |
| 300                           | 17.3205         | 69.282                  | 64.951         | 56.291         | 47.631                    |
| 301                           | 17.3493         | 69.397                  | 65.059         | 56.385         | 47.710                    |
| 302                           | 17.3781         | 69.512                  | 65.167         | 56.478         | 47.789                    |
| 303                           | 17.4068         | 69.627                  | 65.274         | 56.572         | 47.868                    |
| 304                           | 17.4355         | 69.742                  | 65.383         | 56.665         | 47.947                    |
| 305                           | 17.4642         | 69.856                  | 65.490         | 56.768         | 48.026                    |
| 306                           | 17.4928         | 69.971                  | 65.598         | 56.851         | 48.145                    |
| 307                           | 17.5214         | 70.085                  | 65.705         | 56.944         | 48.183                    |
| 308                           | 17.5499         | 70.199                  | 65.812         | 57.037         | 48.262                    |
| 309                           | 17.5783         | 70.313                  | 65.918         | 57.129         | 48.340                    |
| 310                           | 17.6068         | 70.427                  | 66.025         | 57.222         | 48.418                    |
| 311                           | 17.6351         | 70.540                  | 66.141         | 57.324         | 48.506                    |
| 312                           | 17.6635         | 70.654                  | 66.238         | 57.406         | 48.574                    |
| 313                           | 17.6918         | 70.767                  | 66.344         | 57.498         | 48.652                    |
| 314                           | 17.7200         | 70.880                  | 66.450         | 57.590         | 48.730                    |
| 315                           | 17.7482         | 70.992                  | 66.555         | 57.681         | 48.807                    |
| 316                           | 17.7763         | 71.105                  | 66.660         | 57.773         | 48.884                    |
| 317                           | 17.8044         | 71.217                  | 66.766         | 57.864         | 48.962                    |
| 318                           | 17.8325         | 71.330                  | 66.871         | 57.955         | 49.039                    |



## CONTINUATION OF THE TWIST TABLE.

| Counts<br>or<br>num-<br>bers. | Square<br>root. | Extra<br>mule<br>twist. | Mule<br>twist. | Weft<br>twist. | Twist<br>for<br>doubling. |
|-------------------------------|-----------------|-------------------------|----------------|----------------|---------------------------|
| 319                           | 17.8605         | 71.442                  | 66.976         | 57.946         | 49.116                    |
| 320                           | 17.8885         | 71.554                  | 67.081         | 58.137         | 49.193                    |
| 321                           | 17.9164         | 71.665                  | 67.186         | 58.228         | 49.370                    |
| 322                           | 17.9443         | 71.777                  | 67.291         | 58.319         | 49.346                    |
| 323                           | 17.9722         | 71.888                  | 67.395         | 58.409         | 49.423                    |
| 324                           | 18.0000         | 72.000                  | 67.500         | 58.500         | 49.500                    |
| 325                           | 18.0277         | 72.110                  | 67.604         | 58.590         | 49.576                    |
| 326                           | 18.0554         | 72.222                  | 67.707         | 58.680         | 49.652                    |
| 327                           | 18.0831         | 72.332                  | 67.812         | 58.770         | 49.728                    |
| 328                           | 18.1107         | 72.442                  | 67.915         | 58.859         | 49.804                    |
| 329                           | 18.1383         | 72.553                  | 68.018         | 58.949         | 49.880                    |
| 330                           | 18.1659         | 72.663                  | 68.122         | 59.039         | 49.956                    |
| 331                           | 18.1934         | 72.773                  | 68.225         | 59.128         | 50.031                    |
| 332                           | 18.2208         | 72.883                  | 68.328         | 59.217         | 50.106                    |
| 333                           | 18.2482         | 72.992                  | 68.430         | 59.306         | 50.182                    |
| 334                           | 18.2756         | 73.102                  | 68.533         | 59.395         | 50.258                    |
| 335                           | 18.3030         | 73.212                  | 68.636         | 59.484         | 50.333                    |
| 336                           | 18.3303         | 73.321                  | 68.738         | 59.573         | 50.408                    |
| 337                           | 18.3575         | 73.430                  | 68.840         | 59.661         | 50.483                    |
| 338                           | 18.3847         | 73.538                  | 68.942         | 59.750         | 50.558                    |
| 339                           | 18.4119         | 73.647                  | 69.044         | 59.838         | 50.632                    |
| 340                           | 18.4390         | 73.756                  | 69.146         | 59.926         | 50.707                    |
| 341                           | 18.4661         | 73.864                  | 69.248         | 60.014         | 50.781                    |
| 342                           | 18.4932         | 73.972                  | 69.369         | 60.103         | 50.856                    |
| 343                           | 18.5202         | 74.080                  | 69.450         | 60.190         | 50.930                    |
| 344                           | 18.5472         | 74.188                  | 69.552         | 60.278         | 51.004                    |
| 345                           | 18.5741         | 74.296                  | 69.652         | 60.365         | 51.078                    |
| 346                           | 18.6010         | 74.404                  | 69.753         | 60.453         | 51.152                    |
| 347                           | 18.6279         | 74.511                  | 69.884         | 60.540         | 51.226                    |
| 348                           | 18.6547         | 74.618                  | 69.955         | 60.627         | 51.300                    |
| 349                           | 18.6815         | 74.726                  | 70.055         | 60.714         | 51.354                    |
| 350                           | 18.7082         | 74.832                  | 70.155         | 60.801         | 51.447                    |



## A T A B L E

Showing the quality of cotton twist, or warp yarn, by the weight that one lea or the seventh part of a hank will bear before breaking, given in pounds and ounces.

| Ordinary quality. |     |     | Fair quality. |     |     | Good quality. |     |     | Extra quality. |     |     | Super extra quality. |     |     |
|-------------------|-----|-----|---------------|-----|-----|---------------|-----|-----|----------------|-----|-----|----------------------|-----|-----|
| Counts.           | lb. | oz. | Counts.       | lb. | oz. | Counts.       | lb. | oz. | Counts.        | lb. | oz. | Counts.              | lb. | oz. |
| 10                | 115 | 10  | 10            | 120 | 8   | 10            | 125 | 6   | 10             | 130 | 4   | 10                   | 135 | 3   |
| 11                | 102 | 4   | 11            | 104 | 7   | 11            | 106 | 10  | 11             | 108 | 14  | 11                   | 111 | 2   |
| 12                | 96  | 15  | 12            | 99  | 2   | 12            | 100 | 5   | 12             | 103 | 8   | 12                   | 105 | 12  |
| 13                | 91  | 14  | 13            | 93  | 15  | 13            | 96  | 0   | 13             | 98  | 2   | 13                   | 100 | 4   |
| 14                | 89  | 12  | 14            | 91  | 12  | 14            | 93  | 13  | 14             | 95  | 14  | 14                   | 97  | 15  |
| 15                | 83  | 12  | 15            | 85  | 10  | 15            | 87  | 8   | 15             | 89  | 7   | 15                   | 91  | 6   |
| 16                | 81  | 11  | 16            | 83  | 8   | 16            | 85  | 6   | 16             | 87  | 4   | 16                   | 89  | 2   |
| 17                | 76  | 14  | 17            | 78  | 10  | 17            | 80  | 6   | 17             | 82  | 2   | 17                   | 83  | 14  |
| 18                | 72  | 10  | 18            | 74  | 4   | 18            | 75  | 14  | 18             | 77  | 8   | 18                   | 79  | 3   |
| 20                | 67  | 14  | 20            | 69  | 6   | 20            | 70  | 14  | 20             | 72  | 7   | 20                   | 74  | 0   |
| 22                | 61  | 11  | 22            | 63  | 1   | 22            | 64  | 7   | 22             | 65  | 14  | 22                   | 67  | 5   |
| 24                | 58  | 10  | 24            | 59  | 15  | 24            | 61  | 4   | 24             | 62  | 9   | 24                   | 63  | 15  |
| 26                | 54  | 10  | 26            | 55  | 13  | 26            | 57  | 1   | 26             | 58  | 5   | 26                   | 59  | 9   |
| 28                | 50  | 4   | 28            | 51  | 6   | 28            | 52  | 8   | 28             | 53  | 10  | 28                   | 54  | 13  |
| 30                | 48  | 11  | 30            | 49  | 12  | 30            | 50  | 13  | 30             | 51  | 14  | 30                   | 53  | 0   |
| 32                | 45  | 9   | 32            | 46  | 7   | 32            | 47  | 5   | 32             | 48  | 3   | 32                   | 49  | 2   |
| 34                | 44  | 6   | 34            | 45  | 6   | 34            | 46  | 6   | 34             | 47  | 6   | 34                   | 48  | 6   |
| 36                | 41  | 14  | 36            | 42  | 13  | 36            | 43  | 12  | 36             | 44  | 11  | 36                   | 45  | 11  |
| 38                | 39  | 11  | 38            | 40  | 9   | 38            | 41  | 7   | 38             | 42  | 6   | 38                   | 43  | 5   |
| 40                | 38  | 15  | 40            | 39  | 13  | 40            | 40  | 11  | 40             | 41  | 9   | 40                   | 42  | 8   |
| 42                | 37  | 13  | 42            | 38  | 10  | 42            | 39  | 8   | 42             | 40  | 6   | 42                   | 41  | 4   |
| 44                | 35  | 7   | 44            | 36  | 3   | 44            | 37  | 0   | 44             | 37  | 13  | 44                   | 38  | 10  |
| 46                | 33  | 13  | 46            | 34  | 9   | 46            | 35  | 5   | 46             | 36  | 1   | 46                   | 36  | 14  |
| 48                | 32  | 3   | 48            | 32  | 14  | 48            | 33  | 9   | 48             | 34  | 5   | 48                   | 35  | 1   |
| 50                | 32  | 2   | 50            | 32  | 13  | 50            | 33  | 8   | 50             | 34  | 4   | 50                   | 35  | 0   |
| 55                | 30  | 8   | 55            | 31  | 3   | 55            | 31  | 14  | 55             | 32  | 9   | 55                   | 33  | 5   |
| 60                | 27  | 10  | 60            | 28  | 4   | 60            | 28  | 14  | 60             | 29  | 8   | 60                   | 30  | 2   |
| 65                | 25  | 8   | 65            | 26  | 1   | 65            | 26  | 10  | 65             | 27  | 3   | 65                   | 27  | 13  |
| 70                | 24  | 6   | 70            | 24  | 15  | 70            | 25  | 8   | 70             | 26  | 1   | 70                   | 26  | 10  |
| 75                | 22  | 12  | 75            | 23  | 4   | 75            | 23  | 12  | 75             | 24  | 4   | 75                   | 24  | 13  |



## A T A B L E

Showing the quality of cotton twist, or warp yarn, by the weight that one lea or the seventh part of a hank will bear before breaking, given in pounds and ounces.

| Ordinary quality. |         | Fair quality. |         | Good quality. |         | Extra quality. |         | Super extra quality. |         |
|-------------------|---------|---------------|---------|---------------|---------|----------------|---------|----------------------|---------|
| Counts.           | lb. oz. | Counts.       | lb. oz. | Counts.       | lb. oz. | Counts.        | lb. oz. | Counts.              | lb. oz. |
| 80                | 22 0    | 80            | 22 8    | 80            | 23 0    | 80             | 23 8    | 80                   | 24 0    |
| 85                | 20 4    | 85            | 20 13   | 85            | 21 6    | 85             | 21 15   | 85                   | 22 8    |
| 90                | 19 8    | 90            | 19 3    | 90            | 19 14   | 90             | 20 9    | 90                   | 21 5    |
| 95                | 18 8    | 95            | 18 14   | 95            | 19 5    | 95             | 19 12   | 95                   | 20 3    |
| 100               | 18 4    | 100           | 18 10   | 100           | 19 0    | 100            | 19 6    | 100                  | 19 12   |
| 110               | 15 10   | 110           | 16 0    | 110           | 16 5    | 110            | 16 11   | 110                  | 17 0    |
| 120               | 15 8    | 120           | 15 13   | 120           | 16 2    | 120            | 16 7    | 120                  | 16 13   |
| 130               | 14 4    | 130           | 14 9    | 130           | 14 14   | 130            | 15 3    | 130                  | 15 9    |
| 140               | 13 10   | 140           | 13 15   | 140           | 14 4    | 140            | 14 9    | 140                  | 14 14   |
| 150               | 12 7    | 150           | 12 11   | 150           | 12 15   | 150            | 13 4    | 150                  | 13 9    |
| 160               | 12 4    | 160           | 12 8    | 160           | 12 12   | 160            | 13 0    | 160                  | 13 5    |
| 170               | 11 9    | 170           | 11 13   | 170           | 12 1    | 170            | 12 5    | 170                  | 12 9    |
| 180               | 10 10   | 180           | 10 13   | 180           | 11 1    | 180            | 11 5    | 180                  | 11 9    |
| 190               | 10 9    | 190           | 10 12   | 190           | 11 0    | 190            | 11 4    | 190                  | 11 8    |
| 200               | 10 4    | 200           | 10 7    | 200           | 10 11   | 200            | 10 15   | 200                  | 11 3    |
| 210               | 9 13    | 210           | 10 0    | 210           | 10 3    | 210            | 10 7    | 210                  | 10 11   |
| 220               | 9 13    | 220           | 9 15    | 220           | 10 1    | 220            | 10 4    | 220                  | 10 7    |
| 230               | 9 3     | 230           | 9 6     | 230           | 9 9     | 230            | 9 12    | 230                  | 10 0    |
| 240               | 8 14    | 240           | 9 1     | 240           | 9 4     | 240            | 9 7     | 240                  | 9 11    |
| 250               | 8 10    | 250           | 8 13    | 250           | 9 0     | 250            | 9 3     | 250                  | 9 7     |
| 260               | 8 8     | 260           | 8 11    | 260           | 8 14    | 260            | 9 1     | 260                  | 9 4     |
| 270               | 8 3     | 270           | 8 6     | 270           | 8 9     | 270            | 8 12    | 270                  | 8 15    |
| 280               | 8 1     | 280           | 8 4     | 280           | 8 7     | 280            | 8 10    | 280                  | 8 13    |
| 290               | 7 12    | 290           | 7 15    | 290           | 8 2     | 290            | 8 5     | 290                  | 8 8     |
| 300               | 7 11    | 300           | 7 13    | 300           | 8 8     | 300            | 8 3     | 300                  | 8 6     |
| 310               | 7 7     | 310           | 7 9     | 310           | 7 12    | 310            | 7 15    | 310                  | 8 2     |
| 320               | 7 6     | 320           | 7 8     | 320           | 7 10    | 320            | 7 13    | 320                  | 8 0     |
| 330               | 7 2     | 330           | 7 4     | 330           | 7 7     | 330            | 7 10    | 330                  | 7 13    |
| 340               | 6 15    | 340           | 7 1     | 340           | 7 3     | 340            | 7 6     | 340                  | 7 9     |
| 350               | 6 14    | 350           | 7 0     | 350           | 7 2     | 350            | 7 5     | 350                  | 7 8     |



## TWIST MULE SPINNING.

For spinning mule twist of the following counts or numbers, viz., from 6 to 20 hanks in the pound. The produce per week is derived from supposing the mules to work 58 hours per week, and allowing  $7\frac{1}{2}$  per cent for time lost in winding on the yarn, doffing the cops, and other stoppages. The produce is given in pounds and decimal parts of a pound.

| HANKS OF YARN IN THE POUND.....     | 6              | 7              | 8              | 9              | 10             |
|-------------------------------------|----------------|----------------|----------------|----------------|----------------|
| Twist per inch in the yarn.....     | 9.18           | 9.91           | 10.60          | 11.25          | 11.86          |
| Hank roving put up single.....      | $1\frac{1}{8}$ | $1\frac{1}{4}$ | $1\frac{1}{4}$ | $1\frac{3}{8}$ | $1\frac{3}{8}$ |
| Draught in the rollers .....        | 5.33           | 5.60           | 6.40           | 6.54           | 7.27           |
| Traverse of the carriage in inches. | 66             | 66             | 66             | 66             | 66             |
| Revolutions of spindles per draw..  | 605            | 654            | 699            | 742            | 782            |
| Revolutions of spindles per minute  | 3,830          | 4,140          | 4,424          | 4,700          | 4,950          |
| Produce per spindle per week.....   | 7.400          | 6.352          | 5.553          | 5.041          | 4.443          |

  

| HANKS OF YARN IN THE POUND.....     | 11             | 12             | 13             | 14             | 15    |
|-------------------------------------|----------------|----------------|----------------|----------------|-------|
| Twist per inch in the yarn.....     | 12.43          | 13             | 13.52          | 14.01          | 14.52 |
| Hank roving put up single.....      | $1\frac{1}{2}$ | $1\frac{1}{2}$ | $1\frac{3}{4}$ | $1\frac{3}{4}$ | 2     |
| Draught in the rollers .....        | 7.33           | 8              | 7.40           | 8              | 7.50  |
| Traverse of the carriage in inches. | 66             | 66             | 66             | 66             | 66    |
| Revolutions of spindles per draw..  | 820            | 858            | 892            | 924            | 958   |
| Revolutions of spindles per minute  | 5,190          | 5,430          | 5,636          | 5,848          | 6,063 |
| Produce per spindle per week.....   | 4.040          | 3.746          | 3.413          | 3.174          | 2.963 |

  

| HANKS OF YARN IN THE POUND..        | 16    | 17             | 18             | 19             | 20             |
|-------------------------------------|-------|----------------|----------------|----------------|----------------|
| Twist per inch in the yarn.....     | 15    | 15.46          | 15.90          | 16.34          | 16.77          |
| Hank roving put up single.....      | 2     | $2\frac{1}{4}$ | $2\frac{1}{4}$ | $2\frac{1}{2}$ | $2\frac{1}{2}$ |
| Draught in the rollers .....        | 8     | 7.55           | 8              | 7.60           | 8              |
| Traverse of the carriage in inches. | 66    | 66             | 66             | 66             | 66             |
| Revolutions of spindles per draw..  | 990   | 1,020          | 1,049          | 1,080          | 1,106          |
| Revolutions of spindles per minute  | 6,265 | 6,455          | 6,640          | 6,840          | 7,000          |
| Produce per spindle per week.....   | 2.753 | 2.614          | 2.469          | 2.345          | 2.221          |



## MULE SPINNING.

For spinning mule twist of the following counts or numbers, viz., from 22 to 40 hanks in the pound. The production per week is derived from supposing the mules to work 58 hours per week, and allowing  $6\frac{1}{2}$  per cent for time lost in winding on the yarn, doffing the cops, and other stoppages. The produce is given in ounces and decimal parts of an ounce.

| HANKS OF YARN IN THE POUND.....                               | 22    | 24             | 26              | 28              | 30              |
|---------------------------------------------------------------|-------|----------------|-----------------|-----------------|-----------------|
| Twist per inch in the yarn.....                               | 17.59 | 18.37          | 19.12           | 19.84           | 20.53           |
| Hank roving put up double .....                               | 5     | $5\frac{1}{2}$ | $5\frac{3}{4}$  | 6               | $6\frac{1}{2}$  |
| Draught in the rollers .....                                  | 8.66  | 8.59           | 8.88            | 9.15            | 9.02            |
| Cotton delivered by rollers in inches                         | 65    | 65             | $64\frac{3}{4}$ | $64\frac{3}{4}$ | $64\frac{1}{2}$ |
| Gain of the carriage in inches ...                            | 1     | 1              | $1\frac{1}{4}$  | $1\frac{1}{4}$  | $1\frac{1}{2}$  |
| Stretching after rollers stop in }<br>inches .....            | ...   | ...            | ...             | ...             | ...             |
| Traverse of the carriage in inches                            | 66    | 66             | 66              | 66              | 66              |
| Twist per inch while rollers revolve                          | 12.19 | 12.73          | 13.25           | 13.75           | 14.24           |
| Revolutions of the spindles after }<br>the rollers stop ..... | 356   | 372            | 388             | 402             | 416             |
| Revolutions of spindles per draw                              | 1,160 | 1,212          | 1,261           | 1,309           | 1,355           |
| Revolutions of spindles per }<br>minute .....                 | 7,000 | ...            | ...             | ...             | ...             |
| Produce per spindle per week ...                              | 31.70 | 27.33          | 23.78           | 21.26           | 19.56           |

  

| HANKS OF YARN IN THE POUND.....                               | 32              | 34              | 36             | 38              | 40              |
|---------------------------------------------------------------|-----------------|-----------------|----------------|-----------------|-----------------|
| Twist per inch in the yarn.....                               | 21.21           | 21.86           | 22.50          | 23.11           | 23.71           |
| Hank roving put up double .....                               | $6\frac{3}{4}$  | 7               | $7\frac{1}{2}$ | $7\frac{1}{2}$  | 8               |
| Draught in the rollers .....                                  | 9.26            | 9.47            | 9.30           | 9.78            | 9.62            |
| Cotton delivered by rollers in inches                         | $64\frac{1}{2}$ | $64\frac{1}{4}$ | 64             | $63\frac{3}{4}$ | $63\frac{1}{2}$ |
| Gain of the carriage in inches.....                           | $1\frac{1}{2}$  | $1\frac{3}{4}$  | 2              | $2\frac{1}{4}$  | $2\frac{1}{2}$  |
| Stretching after rollers stop in }<br>inches .....            | ...             | ...             | ...            | ...             | ...             |
| Traverse of the carriage in inches                            | 66              | 66              | 66             | 66              | 66              |
| Twist per inch while rollers revolve                          | 14.70           | 15.16           | 15.60          | 16.02           | 16.44           |
| Revolutions of the spindles after }<br>the rollers stop ..... | 427             | 442             | 459            | 468             | 480             |
| Revolutions of spindles per draw                              | 1,399           | 1,442           | 1,488          | 1,525           | 1,565           |
| Revolutions of spindles per }<br>minute .....                 | 7,000           | ...             | ...            | ...             | ...             |
| Produce per spindle per week ...                              | 17.75           | 16.21           | 14.87          | 13.72           | 12.70           |



## MULE SPINNING.

For spinning mule twist of the following counts or numbers, viz., from 42 to 75 hanks in the pound. The production per week is derived from supposing the mules to work 58 hours per week, and allowing  $6\frac{1}{2}$  per cent for time lost in winding on the yarn, doffing the cops, and other stoppages. The produce is given in ounces and decimal parts of an ounce.

| HANKS OF YARN IN THE POUND.....                               | 42              | 44             | 46              | 48              | 50              |
|---------------------------------------------------------------|-----------------|----------------|-----------------|-----------------|-----------------|
| Twist per inch in the yarn.....                               | 24.32           | 24.87          | 25.43           | 25.98           | 26.51           |
| Hank roving put up double .....                               | 8               | $8\frac{1}{2}$ | 9               | 9               | $9\frac{1}{2}$  |
| Draught in the rollers.....                                   | 10.04           | 9.86           | 9.70            | 10.08           | 9.91            |
| Cotton delivered by rollers in inches                         | $61\frac{1}{4}$ | 61             | $60\frac{3}{4}$ | $60\frac{1}{2}$ | $60\frac{1}{4}$ |
| Gain of the carriage in inches.....                           | $2\frac{3}{4}$  | 3              | $3\frac{1}{4}$  | $3\frac{1}{2}$  | $3\frac{3}{4}$  |
| Stretching after rollers stop in }<br>inches .....            | ...             | ...            | ...             | ...             | ...             |
| Traverse of the carriage in inches                            | 64              | 64             | 64              | 64              | 64              |
| Twist per inch while rollers revolve                          | 16.86           | 17.24          | 17.63           | 18.01           | 18.38           |
| Revolutions of the spindles after }<br>the rollers stop ..... | 479             | 488            | 499             | 510             | 520             |
| Revolutions of spindles per draw                              | 1,558           | 1,591          | 1,627           | 1,662           | 1,696           |
| Revolutions of spindles per }<br>minute .....                 | 7,000           | ...            | ...             | ...             | ...             |
| Produce per spindle per week.....                             | 11.86           | 11.07          | 10.35           | 9.715           | 9.140           |

| HANKS OF YARN IN THE POUND.....                               | 55              | 60              | 65              | 70              | 75    |
|---------------------------------------------------------------|-----------------|-----------------|-----------------|-----------------|-------|
| Twist per inch in the yarn.....                               | 27.81           | 29.04           | 30.23           | 31.36           | 32.47 |
| Hank roving put up double .....                               | $10\frac{1}{2}$ | 11              | 12              | 13              | 14    |
| Draught in the rollers.....                                   | 9.80            | 10.16           | 10.04           | 9.94            | 9.85  |
| Cotton delivered by rollers in inches                         | 58              | $57\frac{3}{4}$ | $57\frac{1}{2}$ | $57\frac{1}{4}$ | 57    |
| Gain of the carriage in inches.....                           | 4               | $4\frac{1}{4}$  | $4\frac{1}{2}$  | $4\frac{3}{4}$  | 5     |
| Stretching after rollers stop in }<br>inches .....            | ...             | ...             | ...             | ...             | ...   |
| Traverse of the carriage in inches                            | 62              | 62              | 62              | 62              | 62    |
| Twist per inch while rollers revolve                          | 19.28           | 20.14           | 20.96           | 21.75           | 22.51 |
| Revolutions of the spindles after }<br>the rollers stop ..... | 529             | 552             | 573             | 596             | 618   |
| Revolutions of spindles per draw                              | 1,724           | 1,800           | 1,874           | 1,944           | 2,013 |
| Revolutions of spindles per }<br>minute .....                 | 7,000           | ...             | ...             | ...             | ...   |
| Produce per spindle per week ...                              | 7.920           | 6.953           | 6.165           | 5.518           | 4.974 |



## MULE SPINNING.

For spinning mule twist of the following counts or numbers, viz., from 80 to 150 hanks in the pound. The production per week is derived from supposing the mules to work 58 hours per week, and allowing 6 per cent for time lost in winding on the yarn, doffing the cops, and other stoppages. The produce is given in ounces and decimal parts of an ounce.

| HANKS OF YARN IN THE POUND.....                               | 80    | 85    | 90    | 95    | 100   |
|---------------------------------------------------------------|-------|-------|-------|-------|-------|
| Twist per inch in the yarn.....                               | 33·54 | 34·57 | 35·58 | 36·55 | 37·50 |
| Hank roving put up double .....                               | 15    | 16    | 17    | 18    | 19    |
| Draught in the rollers.....                                   | 9·60  | 9·54  | 9·49  | 9·44  | 9·39  |
| Cotton delivered by rollers in inches                         | 54    | 53    | 52    | 51    | 50    |
| Gain of the carriage in inches.....                           | 5     | 5     | 5     | 5     | 5     |
| Stretching after rollers stop in }<br>inches .....            | 1     | 1     | 1     | 1     | 1     |
| Traverse of the carriage in inches                            | 60    | 59    | 58    | 57    | 56    |
| Twist per inch while rollers revolve                          | 23·25 | 23·97 | 24·66 | 25·34 | 26    |
| Revolutions of the spindles after }<br>the rollers stop ..... | 641   | 649   | 658   | 664   | 670   |
| Revolutions of spindles per draw...                           | 2,012 | 2,039 | 2,063 | 2,083 | 2,100 |
| Revolutions of spindles per }<br>minute .....                 | 7,000 | ...   | ...   | ...   | ...   |
| Produce per spindle per week.....                             | 4·260 | 4·066 | 3·732 | 3·488 | 3·227 |

  

| HANKS OF YARN IN THE POUND.....                              | 110              | 120              | 130              | 140              | 150              |
|--------------------------------------------------------------|------------------|------------------|------------------|------------------|------------------|
| Twist per inch in the yarn .....                             | 39·33            | 41·07            | 42·75            | 44·37            | 45·92            |
| Hank roving put up double .....                              | 20               | 21               | 22               | 24               | 25               |
| Draught in the rollers.....                                  | 9·77             | 10·13            | 10·49            | 10·33            | 10·63            |
| Cotton delivered by rollers in inches                        | 49 $\frac{3}{4}$ | 49 $\frac{3}{4}$ | 49 $\frac{3}{4}$ | 48 $\frac{3}{4}$ | 48 $\frac{3}{4}$ |
| Gain of the carriage in inches.....                          | 5                | 5                | 5                | 5                | 5                |
| Stretching after rollers stop in }<br>inches .....           | 1 $\frac{1}{4}$  | 1 $\frac{1}{4}$  | 1 $\frac{1}{4}$  | 1 $\frac{1}{4}$  | 1 $\frac{1}{4}$  |
| Traverse of the carriage in inches                           | 56               | 56               | 56               | 55               | 55               |
| Twist per inch while rollers revolve                         | 27·27            | 28·48            | 29·64            | 30·76            | 31·84            |
| Revolutions of the spindles after }<br>the rollers stop..... | 707              | 740              | 772              | 787              | 814              |
| Revolutions of spindles per draw...                          | 2,202            | 2,299            | 2,394            | 2,440            | 2,525            |
| Revolutions of spindles per }<br>minute .....                | 7,000            | ...              | ...              | ...              | ...              |
| Produce per spindle per week.....                            | 2·800            | 2·457            | 2·178            | 1·949            | 1·757            |



## MULE SPINNING.

For spinning mule twist of the following counts or numbers, viz., from 160 to 250 hanks in the pound. The production per week is derived from supposing the mules to work 58 hours per week, and allowing 6 per cent for time lost in winding on the yarn, doffing the cops, and other stoppages. The produce is given in grains and decimal parts of a grain.

| HANKS OF YARN IN THE POUND.....                              | 160   | 170   | 180   | 190   | 200   |
|--------------------------------------------------------------|-------|-------|-------|-------|-------|
| Twist per inch in the yarn... ..                             | 47.43 | 48.89 | 50.31 | 51.69 | 53.03 |
| Hank roving put up double .....                              | 27    | 28    | 29    | 30    | 31    |
| Draught in the rollers.....                                  | 10.45 | 10.69 | 10.93 | 11.14 | 11.35 |
| Cotton delivered by rollers in inches                        | 48½   | 48    | 48    | 47½   | 47½   |
| Gain of the carriage in inches.....                          | 5     | 5     | 5     | 5     | 5     |
| Stretching after rollers stop in }<br>inches .....           | 1½    | 1½    | 1½    | 1½    | 1½    |
| Traverse of the carriage in inches                           | 55    | 54½   | 54½   | 54    | 54    |
| Twist per inch while rollers revolve                         | 32.88 | 33.89 | 34.88 | 35.83 | 36.76 |
| Revolutions of the spindles after }<br>the rollers stop..... | 849   | 868   | 893   | 900   | 934   |
| Revolutions of spindles per draw...                          | 2,608 | 2,664 | 2,741 | 2,791 | 2,863 |
| Revolutions of spindles per }<br>minute .....                | 7,000 | ...   | ...   | ...   | ...   |
| Produce per spindle per week.....                            | 698.4 | 637.7 | 585.3 | 539.6 | 475.9 |

  

| HANKS OF YARN IN THE POUND.....                              | 210   | 220   | 230   | 240   | 250   |
|--------------------------------------------------------------|-------|-------|-------|-------|-------|
| Twist per inch in the yarn.....                              | 54.34 | 55.62 | 56.87 | 58.09 | 59.29 |
| Hank roving put up double .....                              | 32    | 33    | 34    | 35    | 36    |
| Draught in the rollers.....                                  | 11.54 | 11.65 | 11.82 | 11.92 | 12.05 |
| Cotton delivered by rollers in inches                        | 47½   | 46¾   | 46¾   | 46½   | 46    |
| Gain of the carriage in inches.....                          | 5     | 5     | 5     | 5¼    | 5¼    |
| Stretching after rollers stop in }<br>inches .....           | 1½    | 1¾    | 1¾    | 1¾    | 1¾    |
| Traverse of the carriage in inches                           | 54    | 53½   | 53½   | 53½   | 53    |
| Twist per inch while rollers revolve                         | 37.67 | 38.56 | 39.43 | 40.27 | 41.10 |
| Revolutions of the spindles after }<br>the rollers stop..... | 957   | 980   | 1,002 | 1,014 | 1,036 |
| Revolutions of spindles per draw...                          | 2,934 | 2,975 | 3,042 | 3,107 | 3,141 |
| Revolutions of spindles per }<br>minute .....                | 7,000 | ...   | ...   | ...   | ...   |
| Produce per spindle per week.....                            | 464.4 | 433.1 | 405.2 | 380.1 | 361.8 |



## MULE SPINNING.

For spinning mule twist of the following counts or numbers, viz., from 260 to 350 hanks in the pound. The production per week is derived from supposing the mules to work 58 hours per week, and allowing 6 per cent for time lost in winding on the yarn, doffing the cops, and other stoppages. The produce is given in grains and decimal parts of a grain.

| HANKS OF YARN IN THE POUND...                                 | 260             | 270              | 280              | 290              | 300              |
|---------------------------------------------------------------|-----------------|------------------|------------------|------------------|------------------|
| Twist per inch in the yarn.....                               | 60·46           | 61·61            | 62·74            | 63·85            | 64·95            |
| Hank roving put up double .....                               | 37              | 38               | 39               | 40               | 41               |
| Draught in the rollers .....                                  | 12·19           | 12·27            | 12·37            | 12·42            | 12·47            |
| Cotton delivered by rollers in inches                         | 46              | 45 $\frac{3}{4}$ | 45 $\frac{1}{4}$ | 45               | 44 $\frac{3}{4}$ |
| Gain of the carriage in inches ...                            | 5 $\frac{1}{4}$ | 5 $\frac{1}{2}$  | 5 $\frac{1}{2}$  | 5 $\frac{1}{2}$  | 5 $\frac{3}{4}$  |
| Stretching after rollers stop in }<br>inches .....            | 1 $\frac{3}{4}$ | 1 $\frac{3}{4}$  | 1 $\frac{3}{4}$  | 2                | 2                |
| Traverse of the carriage in inches                            | 53              | 53               | 52 $\frac{1}{2}$ | 52 $\frac{1}{2}$ | 52 $\frac{1}{2}$ |
| Twist per inch while rollers revolve                          | 41·92           | 42·72            | 43·50            | 44·27            | 45·03            |
| Revolutions of the spindles after }<br>the rollers stop ..... | 1,056           | 1,076            | 1,086            | 1,117            | 1,135            |
| Revolutions of spindles per draw...                           | 3,204           | 3,265            | 3,293            | 3,352            | 3,409            |
| Revolutions of spindles per }<br>minute .....                 | 7,000           | ...              | ...              | ...              | ...              |
| Produce of spindle per week .....                             | 337             | 318              | 301·8            | 286·3            | 272              |

  

| HANKS OF YARN IN THE POUND...                                 | 310   | 320              | 330              | 340              | 350   |
|---------------------------------------------------------------|-------|------------------|------------------|------------------|-------|
| Twist per inch in the yarn.....                               | 66    | 67·08            | 68·12            | 69·14            | 70·43 |
| Hank roving put up double .....                               | 42    | 43               | 44               | 45               | 46    |
| Draught in the rollers.....                                   | 12·49 | 12·51            | 12·54            | 12·51            | 12·47 |
| Cotton delivered by rollers in inches                         | 44    | 43 $\frac{3}{4}$ | 43 $\frac{1}{2}$ | 42 $\frac{1}{4}$ | 41    |
| Gain of the carriage in inches ...                            | 6     | 6                | 6                | 6                | 6     |
| Stretching after rollers stop in }<br>inches .....            | 2     | 2 $\frac{1}{4}$  | 2 $\frac{1}{2}$  | 2 $\frac{3}{4}$  | 3     |
| Traverse of the carriage in inches                            | 52    | 52               | 52               | 51               | 50    |
| Twist per inch while rollers revolve                          | 45·76 | 46·50            | 47·23            | 47·94            | 48·83 |
| Revolutions of the spindles after }<br>the rollers stop ..... | 1,146 | 1,175            | 1,205            | 1,215            | 1,227 |
| Revolutions of spindles per draw...                           | 3,434 | 3,488            | 3,542            | 3,526            | 3,521 |
| Revolutions of spindles per }<br>minute .....                 | 7,000 | ...              | ...              | ...              | ...   |
| Produce per spindle per week ...                              | 259   | 246·9            | 235·8            | 225·4            | 215·9 |



## EXTRA TWIST SPINNING.

The principal point requiring particular attention in spinning hard yarn, or water twist, upon mules, is to keep the yarn at its proper tension while the carriage is receding from the rollers. If the yarn be too tight to spin well speed the rollers a little, and if too slack slower them. Whichever way the alteration is made it is necessary to correct the counts of yarn at the same time by altering the draught in the rollers in the same proportion.

The allowance of speed between the rollers and carriage is as nine to ten, or ten per cent; that is, while the carriage goes nine the rollers should go ten. This is necessary—just in the same manner as the shrinking of a rope while putting twist into it—and of course will have to be regulated according to the quantity of twist put into the yarn.

As I have no correct data as a guide this must be taken theoretically; and whether I be right or wrong in the allowance given matters but little, as it can be easily rectified.

It should be understood that the full quantity of twist is being put in while the carriage is receding from the rollers, and that when the carriage gets out to its length the draw is complete, and only requires to be wound on the spindles.

I merely introduce the subject of spinning water twist upon mules to show that it can be spun to greater advantage than upon the throstle-frame. In the first place, the cops will hold about three times the quantity of yarn contained on a throstle bobbin, which will give less labour to the winder; and of course there will be considerably less time lost in doffing the cops off the mule than in doffing the bobbins from the throstle; and as respects the power required for the two methods of spinning it will be at least two to one in favour of the mule; the same with respect to the quantity of oil used. The difference in carriage between cops and bobbins will be in something like the same proportion. The wear and tear of throstle bobbins is no small item in the monthly bills, while mules have no such bills to provide for; and I think if we investigate the question of wages, or the immediate cost of the two methods of spinning of the same counts of yarn, that likewise will be in favour of spinning water twist by mules. Suppose we take a pair of self-acting mules of 80 dozen spindles each, we then have 1,920 spindles, with one minder at 30s. per week, one piecer at 15s. per week, and one setter-in and scavenger at 8s. per week = 53s. per week. Then 1,920 spindles, revolving 7,000 times per minute, will produce 1,673lb. of 36's water twist



per week of 58 hours; but it will require 2,686 throstle spindles, revolving 5,000 times per minute, to produce the same quantity of yarn, and will require nine good piecers to attend to 300 spindles each, at 10s. per week. If we rate the proportionate cost of doffing for that number of spindles at 10s. per week, which is very moderate, we shall have the sum of £5 to pay in wages, as the cost of spinning 1,673lb. of throstle yarn or water twist; whereas, by self-acting mules, we have the same weight and counts of yarn produced for the sum of £2 13s.; so, by this, it is clear there is a saving in favour of self-acting mules of something like £2 7s. per week, or nearly one half.

If the above calculation be doubtful, or I may be considered leaning with too much partiality towards self-acting mules, to those who are deeply interested in the subject I would say it is worth their while to investigate the matter fully and impartially, so that they need not be led astray by anyone, and I think they will arrive at a similar conclusion to what I have done.

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As the spinning of yarn for doubling purposes is so simple it is not necessary to lay it down in a tabular form, as it will be found properly arranged in the tables adapted for common mule twist in every respect except the quantity of twist, which will be found in the twist tables under its proper head, and opposite the counts required.



## MULE SPINNING WITH EXTRA TWIST.

For the following counts of numbers, viz, from 6 to 20 hanks per pound. The production per week is derived from supposing the mules to work 58 hours per week, and allowing  $7\frac{1}{2}$  per cent for time lost in winding on the yarn, doffing the cops, and other stoppages. The produce is given in pounds and decimal parts of of a pound.

| HANKS OF YARN IN THE POUND...         | 6               | 7              | 8              | 9              | 10             |
|---------------------------------------|-----------------|----------------|----------------|----------------|----------------|
| Twist per inch in the yarn.....       | 9.79            | 10.58          | 11.31          | 12             | 12.64          |
| Hank roving put up single.....        | $1\frac{1}{8}$  | $1\frac{1}{4}$ | $1\frac{1}{4}$ | $1\frac{3}{8}$ | $1\frac{3}{8}$ |
| Draught in the rollers.....           | 5.85            | 6.15           | 7.03           | 7.19           | 7.98           |
| Cotton delivered by rollers in inches | $72\frac{1}{4}$ | ...            | ...            | ...            | ...            |
| Lost by the carriage in inches ...    | $6\frac{1}{4}$  | ...            | ...            | ...            | ...            |
| Traverse of the carriage in inches    | 66              | ...            | ...            | ...            | ...            |
| Revolutions of spindles per draw      | 646             | 698            | 746            | 792            | 834            |
| Revolutions of spindles per minute    | 3,830           | 4,140          | 4,424          | 4,700          | 4,950          |
| Produce per spindle per week ...      | 6.937           | 5.957          | 5.205          | 4.725          | 4.165          |

  

| HANKS OF YARN IN THE POUND...         | 11              | 12             | 13             | 14             | 15    |
|---------------------------------------|-----------------|----------------|----------------|----------------|-------|
| Twist per inch in the yarn.....       | 13.26           | 13.85          | 14.42          | 14.96          | 15.49 |
| Hank roving put up single.....        | $1\frac{1}{2}$  | $1\frac{1}{2}$ | $1\frac{3}{4}$ | $1\frac{3}{4}$ | 2     |
| Draught in the rollers.....           | 8.05            | 8.78           | 8.16           | 8.78           | 8.23  |
| Cotton delivered by rollers in inches | $72\frac{1}{4}$ | ...            | ...            | ...            | ...   |
| Lost by the carriage in inches ...    | $6\frac{1}{4}$  | ...            | ...            | ...            | ...   |
| Traverse of the carriage in inches    | 66              | ...            | ...            | ...            | ...   |
| Revolutions of spindles per draw      | 875             | 914            | 951            | 987            | 1,022 |
| Revolutions of spindles per minute    | 5,190           | 5,430          | 5,636          | 5,848          | 6,063 |
| Produce per spindle per week.....     | 3.787           | 3.511          | 3.174          | 2.975          | 2.777 |

  

| HANKS OF YARN IN THE POUND...         | 16              | 17             | 18             | 19             | 20             |
|---------------------------------------|-----------------|----------------|----------------|----------------|----------------|
| Twist per inch in the yarn.....       | 16              | 16.49          | 16.97          | 17.43          | 17.88          |
| Hank roving put up single.....        | 2               | $2\frac{1}{4}$ | $2\frac{1}{4}$ | $2\frac{1}{2}$ | $2\frac{1}{2}$ |
| Draught in the rollers.....           | 8.78            | 8.29           | 8.78           | 8.34           | 8.78           |
| Cotton delivered by rollers in inches | $72\frac{1}{4}$ | ...            | ...            | ...            | ...            |
| Lost by the carriage in inches ...    | $6\frac{1}{4}$  | ...            | ...            | ...            | ...            |
| Traverse of the carriage in inches    | 66              | ...            | ...            | ...            | ...            |
| Revolutions of spindles per draw      | 1,056           | 1,088          | 1,120          | 1,150          | 1,180          |
| Revolutions of spindles per minute    | 6,265           | 6,455          | 6,640          | 6,840          | 7,000          |
| Produce per spindle per week.....     | 2.580           | 2.450          | 2.314          | 2.198          | 2.082          |



## MULE SPINNING WITH EXTRA TWIST.

For the following counts or numbers, viz., from 22 to 50 hanks per pound. The production per week is derived from supposing the mules to work 58 hours per week, and allowing  $6\frac{1}{2}$  per cent for time lost in winding on the yarn, doffing the cops, and other stoppages. The produce is given in ounces and decimal parts of an ounce.

| HANKS OF YARN IN THE POUND...       | 22    | 24             | 26             | 28    | 30             |
|-------------------------------------|-------|----------------|----------------|-------|----------------|
| Twist per inch in the yarn .....    | 18.76 | 19.59          | 20.39          | 21.16 | 21.90          |
| Hank roving put up double .....     | 5     | $5\frac{1}{2}$ | $5\frac{3}{4}$ | 6     | $6\frac{1}{2}$ |
| Draught in the rollers.....         | 9.63  | 9.55           | 10.21          | 10.21 | 10.10          |
| Cotton delivered by rollers in inch | 72    | ...            | ...            | ...   | ...            |
| Lost by the carriage in inches ...  | 6     | ...            | ...            | ...   | ...            |
| Traverse of the carriage in inches. | 66    | ...            | ...            | ...   | ...            |
| Revolutions of spindles per draw..  | 1,238 | 1,293          | 1,345          | 1,396 | 1,445          |
| Revolutions of spindles per minute  | 7,000 | ...            | ...            | ...   | ...            |
| Produce per spindle per week ...    | 29.22 | 25.62          | 22.29          | 19.93 | 18.33          |

| HANKS OF YARN IN THE POUND...       | 32             | 34    | 36             | 38             | 40    |
|-------------------------------------|----------------|-------|----------------|----------------|-------|
| Twist per inch in the yarn .....    | 22.62          | 23.32 | 24             | 24.65          | 25.29 |
| Hank roving put up double .....     | $6\frac{3}{4}$ | 7     | $7\frac{1}{2}$ | $7\frac{1}{2}$ | 8     |
| Draught in the rollers.....         | 10.37          | 10.63 | 10.50          | 11.09          | 10.94 |
| Cotton delivered by rollers in inch | 72             | ...   | ...            | ...            | ...   |
| Lost by the carriage in inches ...  | 6              | ...   | ...            | ...            | ...   |
| Traverse of the carriage in inches. | 66             | ...   | ...            | ...            | ...   |
| Revolutions of spindles per draw..  | 1,493          | 1,539 | 1,584          | 1,627          | 1,669 |
| Revolutions of spindles per minute  | 7,000          | ...   | ...            | ...            | ...   |
| Produce per spindle per week ...    | 16.64          | 15.19 | 13.94          | 12.86          | 11.90 |

| HANKS OF YARN IN THE POUND...       | 42    | 44             | 46    | 48    | 50             |
|-------------------------------------|-------|----------------|-------|-------|----------------|
| Twist per inch in the yarn .....    | 25.92 | 26.53          | 27.12 | 27.71 | 28.28          |
| Hank roving put up double .....     | 8     | $8\frac{1}{2}$ | 9     | 9     | $9\frac{1}{2}$ |
| Draught in the rollers.....         | 11.48 | 11.32          | 11.11 | 11.66 | 11.51          |
| Cotton delivered by rollers in inch | 70    | ...            | ...   | ...   | ...            |
| Lost by the carriage in inches ...  | 6     | ...            | ...   | ...   | ...            |
| Traverse of the carriage in inches. | 64    | ...            | ...   | ...   | ...            |
| Revolutions of spindles per draw..  | 1,658 | 1,698          | 1,735 | 1,773 | 1,809          |
| Revolutions of spindles per minute  | 7,000 | ...            | ...   | ...   | ...            |
| Produce per spindle per week ...    | 11.11 | 10.37          | 9.703 | 9.107 | 8.568          |



## MULE SPINNING.—SUPER-EXTRA YARN.

This kind of yarn may be used in many cases instead of doubled yarn, on account of its having extra twist put in ; but it must be acknowledged that doubled yarn is far superior in quality to single yarn of any description. Super-extra yarn is spun in the same manner as common mule twist for power-loom warps, with the exception of having more twist put in it, and the carriage being required to move towards the rollers while the yarn is receiving the extra twist, otherwise there would be too much breakage in the yarn, which should be guarded against in all cases. Allowance in shrinkage for extra twist is 6·45 per cent, and the carriage should commence moving towards the rollers when the yarn has received four-fifths of its twist, and continue moving slowly until the whole of the twist is put in or nearly so. Yarn treated in this manner will be as good as it is possible to make single yarn.

For spinning super-extra yarn of the following counts or numbers, viz., from 55 to 75 hanks in the pound. The production per week is derived from supposing the mules to work 58 hours per week, and allowing 6½ per cent for time lost in winding on the yarn, doffing the cops, and other stoppages. The produce is given in ounces and decimal parts of an ounce.

| HANKS OF YARN IN THE POUND...                                 | 55    | 60    | 65    | 70    | 75    |
|---------------------------------------------------------------|-------|-------|-------|-------|-------|
| Twist per inch in the yarn.....                               | 29·66 | 30·98 | 32·24 | 32·46 | 34·64 |
| Hank roving put up double .....                               | 10½   | 11    | 12    | 13    | 14    |
| Draught in the rollers.....                                   | 10·47 | 10·86 | 10·74 | 10·63 | 10·52 |
| Cotton delivered by rollers in inch                           | 58    | 57¾   | 57½   | 57¼   | 57    |
| Gain of the carriage in inches ...                            | 4     | 4¼    | 4½    | 4¾    | 5     |
| Stretching after rollers stop in inch                         | ...   | ...   | ...   | ...   | ...   |
| Traverse of the carriage in inches.                           | 62    | 62    | 62    | 62    | 62    |
| Twist per in. while rollers revolve                           | 18·54 | 19·36 | 20·15 | 20·90 | 21·64 |
| Allowed for shrinkage of the }<br>yarn in inches .....        | 4     | 4     | 4     | 4     | 4     |
| Revolutions of the spindles after }<br>the rollers stop ..... | 687   | 720   | 749   | 778   | 805   |
| Revolutions of spindles per draw..                            | 1,838 | 1,920 | 1,998 | 2,074 | 2,147 |
| Revolutions of spindles per minute                            | 7,000 | ...   | ...   | ...   | ...   |
| Produce per spindle per week ...                              | 7·426 | 6·518 | 5·779 | 5·173 | 4·663 |



For spinning super-extra yarn of the following counts or numbers, viz., from 80 to 150 hanks in the pound. The production per week is derived from supposing the mules to work 58 hours per week, and allowing 6 per cent for time lost in winding on the yarn, doffing the cops, and other stoppages. The produce is given in ounces and decimal parts of an ounce.

| HANKS OF YARN IN THE POUND...                             | 80             | 85             | 90             | 95             | 100            |
|-----------------------------------------------------------|----------------|----------------|----------------|----------------|----------------|
| Twist per inch in the yarn.....                           | 35·776         | 36·878         | 37·947         | 38·986         | 40             |
| Hank roving put up double ...                             | 15             | 16             | 17             | 18             | 19             |
| Draught in the rollers .....                              | 10·24          | 10·19          | 10·14          | 10·08          | 10·02          |
| Cotton delivered by rollers in in.                        | 54             | 53             | 52             | 51             | 50             |
| Gain of the carriage in inches...                         | 5              | 5              | 5              | 5              | 5              |
| Stretching after rollers stop in in.                      | 1              | 1              | 1              | 1              | 1              |
| Traverse of the carriage in in.                           | 60             | 59             | 58             | 57             | 56             |
| Twist per in. while rollers revolve                       | 22·26          | 23·05          | 23·72          | 24·36          | 25             |
| Allowed for shrinkage of the }<br>yarn in inches.....     | $3\frac{3}{4}$ | $3\frac{3}{4}$ | $3\frac{3}{4}$ | $3\frac{5}{8}$ | $3\frac{1}{2}$ |
| Revolutions of spindles after }<br>the rollers stop ..... | 806            | 815            | 825            | 834            | 840            |
| Revolutions of spindles per draw                          | 2,146          | 2,175          | 2,200          | 2,222          | 2,240          |
| Revolutions of the spindles }<br>per minute .....         | 7,000          | ...            | ...            | ...            | ...            |
| Produce per spindle per week...                           | 4·230          | 3·862          | 3·546          | 3·270          | 3·025          |

| HANKS OF YARN IN THE POUND...                             | 110             | 120             | 130             | 140             | 150             |
|-----------------------------------------------------------|-----------------|-----------------|-----------------|-----------------|-----------------|
| Twist per inch in the yarn.....                           | 41·952          | 43·817          | 45·606          | 47·328          | 48·989          |
| Hank roving put up double ...                             | 20              | 21              | 22              | 24              | 25              |
| Draught in the rollers .....                              | 10·42           | 10·82           | 11·20           | 11·04           | 11·35           |
| Cotton delivered by rollers in in.                        | $49\frac{3}{4}$ | $49\frac{3}{4}$ | $49\frac{3}{4}$ | $48\frac{3}{4}$ | $48\frac{3}{4}$ |
| Gain of the carriage in inches...                         | 5               | 5               | 5               | 5               | 5               |
| Stretching after rollers stop in in.                      | $1\frac{1}{4}$  | $1\frac{1}{4}$  | $1\frac{1}{4}$  | $1\frac{1}{4}$  | $1\frac{1}{4}$  |
| Traverse of carriage in inches...                         | 56              | 56              | 56              | 55              | 55              |
| Twist per in. while rollers revolve                       | 26·22           | 27·38           | 28·50           | 29·58           | 30·61           |
| Allowed for shrinkage of the }<br>yarn in inches.....     | $3\frac{1}{2}$  | $3\frac{1}{2}$  | $3\frac{1}{2}$  | $3\frac{1}{2}$  | $3\frac{1}{2}$  |
| Revolutions of spindles after }<br>the rollers stop ..... | 881             | 920             | 958             | 976             | 1,011           |
| Revolutions of spindles per draw                          | 2,349           | 2,476           | 2,554           | 2,603           | 2,694           |
| Revolutions of the spindles }<br>per minute .....         | 7,000           | ...             | ...             | ...             | ...             |
| Produce per spindle per week...                           | 2·625           | 2·303           | 2·021           | 1·824           | 1·64            |



WEFT SLUBBING-FRAMES.

Slubbing-frame suitable for the following numbers of weft yarn, viz., from 6 to 20 hanks in the pound. The produce is given in pounds and decimal parts of a pound, allowing 50 hours per week.

| HANKS OF YARN IN THE POUND...                             | 6                   | 7-8           | 9-10          | 11-12         | 13-14         |
|-----------------------------------------------------------|---------------------|---------------|---------------|---------------|---------------|
| Hank slubbing in the pound .....                          | $\frac{1}{2}$       | $\frac{1}{2}$ | $\frac{1}{2}$ | $\frac{1}{2}$ | $\frac{5}{8}$ |
| Twist per inch in the slubbing ...                        | ·848                | ·848          | ·848          | ·848          | ·948          |
| Decimal hank drawing-frame }<br>sliver .....              | ·125                | ·125          | ·125          | ·125          | ·125          |
| Draught in the rollers.....                               | 4                   | 4             | 4             | 4             | 5             |
| Diameter of the front rollers .....                       | 1 $\frac{1}{4}$ in. | ...           | ...           | ...           | ...           |
| Diameter of the tubes empty.....                          | 1 $\frac{3}{8}$ in. | ...           | ...           | ...           | ...           |
| Diameter of the bobbins when full                         | 5in.                | ...           | ...           | ...           | ...           |
| Length of the lift or traverse.....                       | 10in.               | ...           | ...           | ...           | ...           |
| Laps per inch in the traverse.....                        | 6·57                | ...           | ...           | ...           | 7·35          |
| Diameter of the spindles.....                             | $\frac{3}{4}$       | ...           | ...           | ...           | ...           |
| Revolutions of the spindles per }<br>minute .....         | 500                 | ...           | ...           | ...           | ...           |
| Revolutions of spindles for one }<br>of the rollers ..... | 3·33                | ...           | ...           | ...           | 3·72          |
| Produce per spindle per week.....                         | 117                 | ...           | ...           | ...           | 83·71         |

| HANKS OF YARN IN THE POUND.....                           | 15-16               | 17            | 18            | 19            | 20            |
|-----------------------------------------------------------|---------------------|---------------|---------------|---------------|---------------|
| Hanks of slubbing in the pound...                         | $\frac{3}{4}$       | $\frac{3}{4}$ | $\frac{3}{4}$ | $\frac{3}{4}$ | $\frac{3}{4}$ |
| Twist per inch in the slubbing ...                        | 1·039               | 1·039         | 1·039         | 1·039         | 1·039         |
| Decimal hank of drawing-frame }<br>sliver .....           | ·125                | ·125          | ·125          | ·125          | ·125          |
| Draught in the rollers.....                               | 6                   | 6             | 6             | 6             | 6             |
| Diameter of the front rollers.....                        | 1 $\frac{1}{4}$ in. | ...           | ...           | ...           | ...           |
| Diameter of the tubes empty .....                         | 1 $\frac{3}{8}$ in. | ...           | ...           | ...           | ...           |
| Diameter of the bobbins when full                         | 5in.                | ...           | ...           | ...           | ...           |
| Length of the lift or traverse .....                      | 10in.               | ...           | ...           | ...           | ...           |
| Laps per inch in the traverse.....                        | 8·05                | ...           | ...           | ...           | ...           |
| Diameter of the spindles.....                             | $\frac{3}{4}$       | ...           | ...           | ...           | ...           |
| Revolutions of the spindles per }<br>minute .....         | 500                 | ...           | ...           | ...           | ...           |
| Revolutions of spindles for one of }<br>the rollers ..... | 4·07                | ...           | ...           | ...           | ...           |
| Produce per spindle per week.....                         | 63·78               | ...           | ...           | ...           | ...           |



## WEFT SLUBBING-FRAMES.

Slubbing-frame suitable for the following numbers of weft yarn, viz., from 22 to 40 hanks in the pound. The produce is given in pounds and decimal parts of a pound, allowing 50 hours per week.

| HANKS OF YARN IN THE POUND.....                       | 22                  | 24            | 26            | 28            | 30    |
|-------------------------------------------------------|---------------------|---------------|---------------|---------------|-------|
| Hanks of slubbing in the pound...                     | $\frac{3}{4}$       | $\frac{3}{4}$ | $\frac{7}{8}$ | $\frac{7}{8}$ | 1     |
| Twist per inch in the slubbing ...                    | 1·039               | 1·039         | 1·122         | 1·122         | 1·200 |
| Decimal hank drawing-frame }<br>sliver .....          | ·125                | ·125          | ·125          | ·1428         | ·1428 |
| Draught in the rollers.....                           | 6                   | 6             | 7             | 6·10          | 7     |
| Diameter of the front rollers .....                   | 1 $\frac{1}{4}$ in. | ...           | ...           | ...           | ...   |
| Diameter of the tubes empty.....                      | 1 $\frac{3}{8}$ in. | ...           | ...           | ...           | ...   |
| Diameter of bobbins when full ...                     | 4 $\frac{1}{2}$ in. | ...           | ...           | ...           | ...   |
| Laps per inch in the traverse.....                    | 8·052               | 8·052         | 8·699         | 8·699         | 9·300 |
| Length of the lift or traverse.....                   | 9in.                | ...           | ...           | ...           | ...   |
| Diameter of the spindles.....                         | $\frac{3}{4}$ in.   | ...           | ...           | ...           | ...   |
| Revolutions of spindles per }<br>minute.....          | 545                 | ...           | ...           | ...           | ...   |
| Revolutions of spindles for one }<br>of rollers ..... | 4·08                | 4·08          | 4·40          | 4·40          | 4·71  |
| Produce per spindle per week.....                     | 69·34               | 69·34         | 55·07         | 55·07         | 45·05 |

  

| HANKS OF YARN IN THE POUND.....                       | 32                  | 34     | 36              | 38              | 40              |
|-------------------------------------------------------|---------------------|--------|-----------------|-----------------|-----------------|
| Hanks of slubbing in the pound...                     | 1                   | 1      | 1 $\frac{1}{8}$ | 1 $\frac{1}{8}$ | 1 $\frac{1}{4}$ |
| Twist per inch in the slubbing ...                    | 1·20                | 1·2000 | 1·272           | 1·272           | 1·341           |
| Decimal hank drawing-frame }<br>sliver .....          | ·1666               | ·1666  | ·1666           | ·1666           | ·1666           |
| Draught in the rollers.....                           | 6                   | 6      | 6·75            | 6·75            | 7·45            |
| Diameter of the front rollers .....                   | 1 $\frac{1}{4}$ in. | ...    | ...             | ...             | ...             |
| Diameter of the tubes empty.....                      | 1 $\frac{3}{8}$ in. | ...    | ...             | ...             | ...             |
| Diameter of bobbins when full ...                     | 4 $\frac{1}{2}$ in. | ...    | ...             | ...             | ...             |
| Laps per inch in the traverse.....                    | 9·300               | 9·300  | 9·863           | 9·863           | 10·397          |
| Length of the lift or traverse.....                   | 9in.                | ...    | ...             | ...             | ...             |
| Diameter of the spindles.....                         | $\frac{3}{4}$ in.   | ...    | ...             | ...             | ...             |
| Revolutions of spindles per }<br>minute.....          | 545                 | ...    | ...             | ...             | ...             |
| Revolutions of spindles for one }<br>of rollers ..... | 4·71                | 4·71   | 4·99            | 4·99            | 5·26            |
| Produce per spindle per week.....                     | 45·05               | 45·05  | 37·80           | 37·80           | 32·25           |



## WEFT SLUBBING-FRAMES.

Slubbing-frames suitable for yarn of the following counts or numbers, viz., from 42 to 75 hanks in the pound. The produce is given in pounds and decimal parts of a pound, allowing 50 hours per week.

| HANKS OF YARN IN THE POUND...                        | 42                  | 44            | 46            | 48            | 50            |
|------------------------------------------------------|---------------------|---------------|---------------|---------------|---------------|
| Hanks slubbing in the pound.....                     | $\frac{3}{4}$       | $\frac{3}{4}$ | $\frac{3}{4}$ | $\frac{3}{4}$ | $\frac{3}{4}$ |
| Twist per inch in the slubbing ...                   | 1·039               | ...           | ...           | ...           | ...           |
| Decimal hank drawing-frame }<br>sliver .....         | ·1666               | ...           | ...           | ...           | ...           |
| Draught in the rollers.....                          | 4·50                | ...           | ...           | ...           | ...           |
| Diameter of the front rollers.....                   | 1 $\frac{1}{4}$ in. | ...           | ...           | ...           | ...           |
| Diameter of the tubes empty.....                     | 1 $\frac{3}{8}$ in. | ...           | ...           | ...           | ...           |
| Diameter of the bobbins full.....                    | 4 $\frac{1}{2}$ in. | ...           | ...           | ...           | ...           |
| Laps per inch in lift or traverse...                 | 8·05                | ...           | ...           | ...           | ...           |
| Length of the lift or traverse.....                  | 9in.                | ...           | ...           | ...           | ...           |
| Diameter of the spindles.....                        | $\frac{3}{4}$ in.   | ...           | ...           | ...           | ...           |
| Revolutions of the spindles per }<br>minute .....    | 545                 | ...           | ...           | ...           | ...           |
| Revolutions of spindles for one }<br>of rollers..... | 4·08                | ...           | ...           | ...           | ...           |
| Produce per spindle per week ...                     | 69·34               | ...           | ...           | ...           | ...           |

  

| HANKS OF YARN IN THE POUND...                           | 55                  | 60    | 65              | 70              | 75              |
|---------------------------------------------------------|---------------------|-------|-----------------|-----------------|-----------------|
| Hank slubbing in the pound .....                        | 1                   | 1     | 1 $\frac{1}{8}$ | 1 $\frac{1}{4}$ | 1 $\frac{1}{4}$ |
| Twist per inch in the slubbing ...                      | 1·200               | 1·200 | 1·272           | 1·341           | 1·341           |
| Decimal hank drawing-frame }<br>sliver .....            | ·2083               | ·2083 | ·2083           | ·2083           | ·2083           |
| Draught in the rollers.....                             | 4·80                | 4·80  | 5·40            | 6               | 6               |
| Diameter of the front rollers.....                      | 1 $\frac{1}{4}$ in. | ...   | ...             | ...             | ...             |
| Diameter of the tubes empty.....                        | 1 $\frac{3}{8}$ in. | ...   | ...             | ...             | ...             |
| Diameter of the bobbins full.....                       | 4 $\frac{1}{2}$ in. | ...   | ...             | ...             | ...             |
| Laps per inch in lift or traverse...                    | 9·30                | 9·30  | 9·86            | 10·39           | 10·39           |
| Length of the lift or traverse.....                     | 9in.                | ...   | ...             | ...             | ...             |
| Diameter of the spindles.....                           | $\frac{3}{4}$ in.   | ...   | ...             | ...             | ...             |
| Revolutions of spindles per }<br>minute .....           | 545                 | ...   | ...             | ...             | ...             |
| Revolution of spindles for one }<br>of the rollers..... | 4·71                | 4·71  | 4·98            | 5·26            | 5·26            |
| Produce per spindle per week ...                        | 45·05               | 45·05 | 37·80           | 32·25           | 32·25           |



## WEFT INTERMEDIATE-FRAMES.

Intermediate-frames suitable for yarn of the following counts or numbers, viz., from 42 to 75 hanks in the pound. The produce is given in pounds and decimal parts of a pound, allowing 51 hours per week.

| HANKS OF YARN IN THE POUND...                         | 42                  | 44             | 46             | 48             | 50             |
|-------------------------------------------------------|---------------------|----------------|----------------|----------------|----------------|
| Hanks of intermediate roving }<br>in the pound.....}  | $1\frac{5}{8}$      | $1\frac{3}{4}$ | $1\frac{3}{4}$ | $1\frac{3}{4}$ | $1\frac{3}{4}$ |
| Twist per inch in the roving.....                     | 1.53                | 1.58           | 1.58           | 1.58           | 1.58           |
| Slubbing roving put up double ...                     | $\frac{3}{4}$       | $\frac{3}{4}$  | $\frac{3}{4}$  | $\frac{3}{4}$  | $\frac{3}{4}$  |
| Draught in the rollers .....                          | 4.333               | 4.666          | 4.666          | 4.666          | 4.666          |
| Diameter of the front rollers.....                    | $1\frac{1}{8}$ in.  | ...            | ...            | ...            | ...            |
| Diameter of the tubes empty.....                      | $1\frac{1}{4}$ in.  | ...            | ...            | ...            | ...            |
| Diameter of bobbins when full ...                     | 4in.                | ...            | ...            | ...            | ...            |
| Laps per inch in lift or traverse...                  | 11.84               | 12.30          | 12.30          | 12.30          | 12.30          |
| Length of the lift or traverse.....                   | 8in.                | ...            | ...            | ...            | ...            |
| Diameter of the spindles.....                         | $2\frac{3}{32}$ in. | ...            | ...            | ...            | ...            |
| Revolutions of spindles per }<br>minute .....         | 677                 | ...            | ...            | ...            | ...            |
| Revolutions of spindles for one }<br>of rollers ..... | 5.40                | 6.04           | 6.04           | 6.04           | 6.04           |
| Produce per spindle per week ...                      | 27.55               | 24.77          | 24.77          | 24.77          | 24.77          |

| HANKS OF YARN IN THE POUND...                         | 55                  | 60    | 65             | 70             | 75             |
|-------------------------------------------------------|---------------------|-------|----------------|----------------|----------------|
| Hanks of intermediate roving }<br>in the pound.....}  | $2\frac{3}{4}$      | 3     | $3\frac{1}{4}$ | $3\frac{1}{2}$ | $3\frac{3}{4}$ |
| Twist per inch in the roving.....                     | 1.98                | 2.07  | 2.16           | 2.24           | 2.32           |
| Slubbing roving put up double...                      | 1                   | 1     | $1\frac{1}{8}$ | $1\frac{1}{4}$ | $1\frac{1}{4}$ |
| Draught in the rollers.....                           | 5.50                | 6     | 5.77           | 5.60           | 6              |
| Diameter of the front rollers.....                    | $1\frac{1}{8}$      | ...   | ...            | ...            | ...            |
| Diameter of the tubes empty.....                      | $1\frac{3}{16}$ in. | ...   | ...            | ...            | ...            |
| Diameter of bobbins when full ...                     | $3\frac{1}{2}$ in.  | ...   | ...            | ...            | ...            |
| Laps per inch in lift or traverse...                  | 15.42               | 16.10 | 16.76          | 17.39          | 19.36          |
| Length of the lift or traverse.....                   | 7in.                | ...   | ...            | ...            | ...            |
| Diameter of the spindles.....                         | $2\frac{1}{32}$ in. | ...   | ...            | ...            | ...            |
| Revolutions of spindles per }<br>minute .....         | 750                 | ...   | ...            | ...            | ...            |
| Revolutions of spindles for one }<br>of rollers ..... | 6.99                | 7.31  | 7.63           | 7.88           | 8.19           |
| Produce per spindle per week ...                      | 13.93               | 12.22 | 10.81          | 9.614          | 8.723          |



## WEFT ROVING-FRAMES.

Roving-frames suitable for the following numbers of weft yarn, viz., from 6 to 20 hanks in the pound. The produce is given in pounds and decimal parts of a pound, allowing 51 hours per week.

| HANKS OF YARN IN THE POUND...                         | 6                   | 7-8            | 9-10           | 11-12          | 13-14          |
|-------------------------------------------------------|---------------------|----------------|----------------|----------------|----------------|
| Hanks of roving in the pound ...                      | $1\frac{1}{8}$      | $1\frac{1}{4}$ | $1\frac{3}{8}$ | $1\frac{1}{2}$ | $1\frac{3}{4}$ |
| Twist per inch in the roving .....                    | 1.272               | 1.341          | 1.407          | 1.469          | 1.546          |
| Slubbing roving put up double ...                     | $\frac{1}{2}$       | $\frac{1}{2}$  | $\frac{1}{2}$  | $\frac{1}{2}$  | $\frac{5}{8}$  |
| Draught in the rollers .....                          | 4.50                | 5              | 5.50           | 6              | 5.60           |
| Diameter of the front rollers .....                   | $1\frac{1}{4}$ in.  | ...            | ...            | ...            | ...            |
| Diameter of the tubes empty .....                     | $1\frac{1}{4}$ in.  | ...            | ...            | ...            | ...            |
| Diameter of the bobbins full .....                    | 4 in.               | ...            | ...            | ...            | ...            |
| Length of the lift or traverse ...                    | 8 in.               | ...            | ...            | ...            | ...            |
| Laps per inch in the traverse .....                   | 9.86                | 10.39          | 10.80          | 11.38          | 12.30          |
| Diameter of the spindles .....                        | $\frac{23}{32}$ in. | ...            | ...            | ...            | ...            |
| Revolutions of spindles per }<br>minute .....         | 677                 | ...            | ...            | ...            | ...            |
| Revolutions of spindles for one }<br>of rollers ..... | 4.995               | 5.266          | 5.525          | 5.768          | 6.071          |
| Produce per spindle per week ...                      | 47.87               | 40.86          | 35.40          | 31.08          | 25.30          |

  

| HANKS OF YARN IN THE POUND...                         | 15-16               | 17             | 18             | 19             | 20             |
|-------------------------------------------------------|---------------------|----------------|----------------|----------------|----------------|
| Hanks of roving in the pound ...                      | 2                   | $2\frac{1}{4}$ | $2\frac{1}{4}$ | $2\frac{1}{2}$ | $2\frac{1}{2}$ |
| Twist per inch in the roving .....                    | 1.697               | 1.800          | 1.800          | 1.897          | 1.897          |
| Slubbing roving put up double ...                     | $\frac{3}{4}$       | $\frac{3}{4}$  | $\frac{3}{4}$  | $\frac{3}{4}$  | $\frac{3}{4}$  |
| Draught in the rollers .....                          | 5.33                | 6              | 6              | 6.66           | 6.66           |
| Diameter of the front rollers .....                   | $1\frac{1}{8}$ in.  | ...            | ...            | ...            | ...            |
| Diameter of the tubes empty .....                     | $1\frac{3}{16}$ in. | ...            | ...            | ...            | ...            |
| Diameter of the bobbins full .....                    | $3\frac{1}{2}$ in.  | ...            | ...            | ...            | ...            |
| Length of the lift or traverse ...                    | 7 in.               | ...            | ...            | ...            | ...            |
| Laps per inch in the traverse ...                     | 13.15               | 13.95          | 13.95          | 14.70          | 14.70          |
| Diameter of the spindles .....                        | $\frac{21}{32}$ in. | ...            | ...            | ...            | ...            |
| Revolutions of spindles per }<br>minute .....         | 750                 | ...            | ...            | ...            | ...            |
| Revolutions of spindles for one }<br>of rollers ..... | 5.996               | 6.360          | 6.360          | 6.703          | 6.703          |
| Produce per spindle per week ...                      | 22.36               | 18.73          | 18.73          | 16             | 16             |



## WEFT ROVING-FRAMES.

Roving-frames suitable for the following numbers of weft yarn, viz., from 22 to 40 hanks in the pound. The produce is given in pounds and decimal parts of a pound, allowing 52 hours per week.

| HANKS OF YARN IN THE POUND...                             | 22                  | 24             | 26             | 28            | 30             |
|-----------------------------------------------------------|---------------------|----------------|----------------|---------------|----------------|
| Hanks of roving in the pound .....                        | $2\frac{1}{2}$      | $2\frac{3}{4}$ | $2\frac{7}{8}$ | 3             | $3\frac{1}{4}$ |
| Twist per inch in the roving .....                        | 1.897               | 1.989          | 2.034          | 2.078         | 2.163          |
| Hank slubbing put up double.....                          | $\frac{3}{4}$       | $\frac{3}{4}$  | $\frac{7}{8}$  | $\frac{7}{8}$ | 1              |
| Draught in the rollers.....                               | 6.65                | 7.35           | 6.55           | 7             | 6.50           |
| Diameter of the front rollers .....                       | $1\frac{1}{8}$ in.  | ...            | ...            | ...           | ...            |
| Diameter of the tubes empty .....                         | $1\frac{3}{16}$ in. | ...            | ...            | ...           | ...            |
| Diameter of the bobbins full .....                        | $3\frac{1}{2}$ in.  | ...            | ...            | ...           | ...            |
| Laps per inch in the traverse.....                        | 14.70               | 15.42          | 15.76          | 16.10         | 16.76          |
| Length of the traverse .....                              | 7 in.               | ...            | ...            | ...           | ...            |
| Diameter of the spindles.....                             | $\frac{21}{32}$ in. | ...            | ...            | ...           | ...            |
| Revolutions of spindles per minute                        | 750                 | ...            | ...            | ...           | ...            |
| Revolutions of spindles for one }<br>of the rollers ..... | 6.70                | 6.99           | 7.18           | 7.34          | 7.64           |
| Produce per spindle per week.....                         | 16.06               | 13.90          | 13.23          | 12.41         | 11             |

  

| HANKS OF YARN IN THE POUND...                             | 32                  | 34             | 36             | 38             | 40             |
|-----------------------------------------------------------|---------------------|----------------|----------------|----------------|----------------|
| Hanks of roving in the pound ...                          | $3\frac{3}{8}$      | $3\frac{1}{2}$ | $3\frac{3}{4}$ | $3\frac{3}{4}$ | 4              |
| Twist per inch in the roving .....                        | 2.204               | 2.244          | 2.323          | 2.323          | 2.400          |
| Slubbing roving put up double ...                         | 1                   | 1              | $1\frac{1}{8}$ | $1\frac{1}{8}$ | $1\frac{1}{4}$ |
| Draught in the rollers.....                               | 6.75                | 7              | 6.66           | 6.66           | 6.40           |
| Diameter of the front rollers .....                       | $1\frac{1}{8}$ in.  | ...            | ...            | ...            | ...            |
| Diameter of the tubes empty.....                          | $1\frac{3}{16}$ in. | ...            | ...            | ...            | ...            |
| Diameter of the bobbins full .....                        | $3\frac{1}{2}$ in.  | ...            | ...            | ...            | ...            |
| Laps per inch in the traverse.....                        | 17.08               | 17.39          | 18             | 18             | 18.60          |
| Length of the traverse .....                              | 7 in.               | ...            | ...            | ...            | ...            |
| Diameter of the spindles.....                             | $\frac{21}{32}$ in. | ...            | ...            | ...            | ...            |
| Revolutions of spindles per minute                        | 750                 | ...            | ...            | ...            | ...            |
| Revolutions of spindles for one }<br>of the rollers ..... | 7.78                | 7.93           | 8.21           | 8.21           | 8.48           |
| Produce per spindle per week ...                          | 10.40               | 9.851          | 8.882          | 8.882          | 8.064          |



## WEFT ROVING-FRAMES.

Roving-frames suitable for yarn of the following counts or numbers, viz., from 42 to 75 hanks in the pound. The produce is given in pounds and decimal parts of a pound, allowing 52 hours per week.

| HANKS OF YARN IN THE POUND...                             | 42                 | 44             | 46             | 48             | 50             |
|-----------------------------------------------------------|--------------------|----------------|----------------|----------------|----------------|
| Hanks of roving in the pound.....                         | 4                  | $4\frac{1}{4}$ | $4\frac{1}{2}$ | $4\frac{1}{2}$ | $4\frac{3}{4}$ |
| Twist per inch in the roving .....                        | 2.40               | 2.47           | 2.54           | 2.54           | 2.61           |
| Intermediate roving put up double                         | $1\frac{5}{8}$     | $1\frac{3}{4}$ | $1\frac{3}{4}$ | $1\frac{3}{4}$ | $1\frac{3}{4}$ |
| Draught in the rollers.....                               | 4.923              | 4.859          | 5.142          | 5.142          | 5.428          |
| Diameter of the front rollers .....                       | $1\frac{1}{8}$ in. | ...            | ...            | ...            | ...            |
| Diameter of the tubes empty.....                          | $1\frac{1}{8}$ in. | ...            | ...            | ...            | ...            |
| Diameter of bobbins when full ...                         | 3in.               | ...            | ...            | ...            | ...            |
| Laps per inch in lift or traverse...                      | 18.60              | 19.16          | 19.72          | 19.72          | 20.26          |
| Length of lift or traverse .....                          | 6in.               | ...            | ...            | ...            | ...            |
| Diameter of the spindles.....                             | $\frac{5}{8}$ in.  | ...            | ...            | ...            | ...            |
| Revolutions of spindles per minute                        | 893                | ...            | ...            | ...            | ...            |
| Revolutions of spindles for one }<br>of the rollers ..... | 8.48               | 8.73           | 8.97           | 8.97           | 9.22           |
| Produce per spindle per week.....                         | 9.597              | 8.776          | 8.060          | 8.060          | 7.431          |
| HANKS OF YARN IN THE POUND.....                           | 55                 | 60             | 65             | 70             | 75             |
| Hanks of roving in the pound.....                         | $10\frac{1}{2}$    | 11             | 12             | 13             | 14             |
| Twist per inch in the roving .....                        | 3.88               | 3.97           | 4.15           | 4.32           | 4.48           |
| Intermediate roving put up double                         | $2\frac{3}{4}$     | 3              | $3\frac{1}{4}$ | $3\frac{1}{2}$ | $3\frac{3}{4}$ |
| Draught in the rollers.....                               | 7.63               | 7.33           | 7.40           | 7.57           | 7.46           |
| Diameter of the front rollers .....                       | $1\frac{1}{8}$ in. | ...            | ...            | ...            | ...            |
| Diameter of the tubes empty.....                          | $1\frac{1}{8}$ in. | ...            | ...            | ...            | ...            |
| Diameter of bobbins when full ...                         | $2\frac{3}{4}$ in. | ...            | ...            | ...            | ...            |
| Laps per inch in lift or traverse...                      | 30.13              | 30.83          | 32.21          | 33.53          | 34.79          |
| Length of lift or traverse .....                          | 5in.               | ...            | ...            | ...            | ...            |
| Diameter of the spindles.....                             | $\frac{5}{8}$ in.  | ...            | ...            | ...            | ...            |
| Revolutions of spindles per minute                        | 1,224              | ...            | ...            | ...            | ...            |
| Revolutions of spindles for one }<br>of the rollers ..... | 13.71              | 14.03          | 14.66          | 15.26          | 15.83          |
| Produce per spindle per week ...                          | 3.099              | 2.891          | 2.532          | 2.251          | 2.013          |



## WEFT MULE SPINNING.

For spinning common weft of the following counts or numbers, viz., from 6 to 20 hanks in the pound. The produce per week is derived from supposing the mules to work 58 hours per week, and allowing  $7\frac{3}{4}$  per cent for time lost in winding on the yarn, doffing the cops, and other stoppages. The produce is given in pounds and decimal parts of a pound.

| HANKS OF YARN IN THE POUND....                | 6              | 7              | 8              | 9              | 10             |
|-----------------------------------------------|----------------|----------------|----------------|----------------|----------------|
| Twist per inch in the yarn.....               | 7.96           | 8.59           | 9.19           | 9.75           | 10.27          |
| Hank roving put up single.....                | $1\frac{1}{8}$ | $1\frac{1}{4}$ | $1\frac{1}{4}$ | $1\frac{3}{8}$ | $1\frac{3}{8}$ |
| Draught in the rollers .....                  | 5.33           | 5.60           | 6.40           | 6.54           | 7.27           |
| Traverse of the carriage in inches.           | 66             | 66             | 66             | 66             | 66             |
| Revolutions of spindles per draw .            | 525            | 567            | 606            | 643            | 677            |
| Revolutions of spindles per }<br>minute ..... | 3,400          | 3,672          | 3,938          | 4,164          | 4,384          |
| Produce per spindle per week ...              | 7.550          | 6.483          | 5.686          | 5.037          | 4.531          |

| HANKS OF YARN IN THE POUND...                 | 11             | 12             | 13             | 14             | 15    |
|-----------------------------------------------|----------------|----------------|----------------|----------------|-------|
| Twist per inch in the yarn.....               | 10.77          | 11.25          | 11.71          | 12.16          | 12.48 |
| Hank roving put up single.....                | $1\frac{1}{2}$ | $1\frac{1}{2}$ | $1\frac{3}{4}$ | $1\frac{3}{4}$ | 2     |
| Draught in the rollers .....                  | 7.33           | 8              | 7.40           | 8              | 7.50  |
| Traverse of the carriage in inches.           | 66             | 66             | 66             | 66             | 66    |
| Revolutions of spindles per draw .            | 710            | 742            | 772            | 802            | 823   |
| Revolutions of spindles per }<br>minute ..... | 4,600          | 4,805          | 5,000          | 5,194          | 5,330 |
| Produce per spindle per week ...              | 4.122          | 3.778          | 3.485          | 3.258          | 3.022 |

| HANKS OF YARN IN THE POUND...                 | 16    | 17             | 18             | 19             | 20             |
|-----------------------------------------------|-------|----------------|----------------|----------------|----------------|
| Twist per inch in the yarn.....               | 13    | 13.40          | 13.78          | 14.16          | 14.53          |
| Hank roving put up single.....                | 2     | $2\frac{1}{4}$ | $2\frac{1}{4}$ | $2\frac{1}{2}$ | $2\frac{1}{2}$ |
| Draught in the rollers .....                  | 8     | 7.55           | 8              | 7.60           | 8              |
| Traverse of the carriage in inches            | 66    | 66             | 66             | 66             | 66             |
| Revolutions of spindles per draw              | 858   | 884            | 909            | 934            | 959            |
| Revolutions of spindles per }<br>minute ..... | 5,556 | 5,725          | 5,886          | 6,348          | 6,210          |
| Produce per spindle per week.....             | 2.835 | 2.667          | 2.519          | 2.386          | 2.268          |



## WEFT MULE SPINNING.

For spinning common weft of the following counts or numbers, viz., from 22 to 40 hanks in the pound. The produce per week is derived from supposing the mules to work 58 hours per week, and allowing  $7\frac{1}{2}$  per cent for time lost in winding on the yarn, doffing the cops, and other stoppages. The produce is given in ounces and decimal parts of an ounce.

| HANKS OF YARN IN THE POUND...                                 | 22             | 24             | 26              | 28              | 30              |
|---------------------------------------------------------------|----------------|----------------|-----------------|-----------------|-----------------|
| Twist per inch in the yarn.....                               | 15·24          | 15·92          | 16·57           | 17·19           | 17·80           |
| Hank roving put up single.....                                | $2\frac{1}{2}$ | $2\frac{3}{4}$ | $2\frac{7}{8}$  | 3               | $3\frac{1}{4}$  |
| Draught in the rollers .....                                  | 8·66           | 8·59           | 8·88            | 9·15            | 9·02            |
| Cotton delivered by rollers in inches                         | 65             | 65             | $64\frac{3}{4}$ | $64\frac{3}{4}$ | $64\frac{1}{2}$ |
| Gain of the carriage in inches.....                           | 1              | 1              | $1\frac{1}{4}$  | $1\frac{1}{4}$  | $1\frac{1}{2}$  |
| Traverse of the carriage in inches.                           | 66             | 66             | 66              | 66              | 66              |
| Twist per inch until rollers stop...                          | 12·19          | 12·73          | 13·25           | 13·75           | 14·24           |
| Revolutions of the spindles after {<br>the rollers stop ..... | 201            | 210            | 219             | 227             | 235             |
| Revolutions of spindles per draw..                            | 1,006          | 1,050          | 1,093           | 1,134           | 1,174           |
| Revolutions of spindles per {<br>minute .....                 | 6,514          | 6,800          | 7,000           | ...             | ...             |
| Produce per spindle per week.....                             | 33·07          | 30·32          | 27·68           | 24·76           | 22·32           |

  

| HANKS OF YARN IN THE POUND...                                 | 32              | 34              | 36             | 38              | 40              |
|---------------------------------------------------------------|-----------------|-----------------|----------------|-----------------|-----------------|
| Twist per inch in the yarn.....                               | 18·38           | 18·95           | 19·50          | 20·03           | 20·55           |
| Hank roving put up single.....                                | $3\frac{3}{8}$  | $3\frac{1}{2}$  | $3\frac{3}{4}$ | $3\frac{3}{4}$  | 4               |
| Draught in the rollers .....                                  | 9·26            | 9·47            | 9·30           | 9·78            | 9·62            |
| Cotton delivered by rollers in inches                         | $64\frac{1}{2}$ | $64\frac{1}{4}$ | 64             | $63\frac{3}{4}$ | $63\frac{1}{2}$ |
| Gain of the carriage in inches.....                           | $1\frac{1}{2}$  | $1\frac{3}{4}$  | 2              | $2\frac{1}{4}$  | $2\frac{1}{2}$  |
| Twist per inch until rollers stop...                          | 14·70           | 15·16           | 15·60          | 16·02           | 16·44           |
| Traverse of the carriage in inches.                           | 66              | 66              | 66             | 66              | 66              |
| Revolutions of the spindles after {<br>the rollers stop ..... | 243             | 250             | 258            | 265             | 271             |
| Revolutions of spindles per draw..                            | 1,213           | 1,250           | 1,287          | 1,321           | 1,356           |
| Revolutions of spindles per {<br>minute .....                 | 7,000           | ...             | ...            | ...             | ...             |
| Produce per spindle per week.....                             | 20·27           | 18·70           | 16·98          | 15·66           | 14·50           |



## WEFT MULE SPINNING.

For spinning weft yarn of the following counts or numbers, viz., from 42 to 75 hanks in the pound. The production per week is derived from supposing the mules to work 58 hours per week, and allowing 7 per cent for time lost in winding on the yarn, doffing the cops, and other stoppages. The produce is given in ounces and decimal parts of an ounce.

| HANKS OF YARN IN THE POUND.....                              | 42              | 44             | 46              | 48              | 50              |
|--------------------------------------------------------------|-----------------|----------------|-----------------|-----------------|-----------------|
| Twist per inch in the yarn.....                              | 21·05           | 21·55          | 22·04           | 22·51           | 22·98           |
| Hank roving put up single.....                               | 4               | $4\frac{1}{4}$ | $4\frac{1}{2}$  | $4\frac{1}{2}$  | $4\frac{3}{4}$  |
| Draught in the rollers.....                                  | 10·04           | 9·86           | 9·70            | 10·08           | 9·91            |
| Cotton delivered by rollers in }<br>inches .....             | $61\frac{1}{4}$ | 61             | $60\frac{3}{4}$ | $60\frac{1}{2}$ | $60\frac{1}{4}$ |
| Gain of the carriage in inches.....                          | $2\frac{3}{4}$  | 3              | $3\frac{1}{4}$  | $3\frac{1}{2}$  | $3\frac{3}{4}$  |
| Traverse of the carriage in inches                           | 64              | 64             | 64              | 64              | 64              |
| Twist per inch while rollers revolve                         | 16·86           | 17·24          | 17·63           | 18·01           | 18·38           |
| Revolutions of the spindles after }<br>the rollers stop..... | 272             | 276            | 283             | 288             | 294             |
| Revolutions of the spindles per }<br>draw.....               | 1,347           | 1,379          | 1,410           | 1,440           | 1,470           |
| Revolutions of the spindles per }<br>minute .....            | 7,000           | ...            | ...             | ...             | ...             |
| Produce per spindle per week.....                            | 13·55           | 12·64          | 11·83           | 11·09           | 10·43           |

  

| HANKS OF YARN IN THE POUND.....                              | 55              | 60              | 65              | 70              | 75    |
|--------------------------------------------------------------|-----------------|-----------------|-----------------|-----------------|-------|
| Twist per inch in the yarn .....                             | 24·10           | 25·17           | 26·20           | 27·19           | 28·14 |
| Hank roving put up double.....                               | $10\frac{1}{2}$ | 11              | 12              | 13              | 14    |
| Draught in the rollers.....                                  | 9·80            | 10·16           | 10·04           | 9·94            | 9·85  |
| Cotton delivered by rollers in }<br>inches .....             | 58              | $57\frac{3}{4}$ | $57\frac{1}{2}$ | $57\frac{1}{4}$ | 57    |
| Gain of the carriage in inches.....                          | 4               | $4\frac{1}{4}$  | $4\frac{1}{2}$  | $4\frac{3}{4}$  | 5     |
| Traverse of the carriage in inches                           | 62              | 62              | 62              | 62              | 62    |
| Twist per inch while rollers revolve                         | 19·28           | 20·14           | 20·96           | 21·75           | 22·51 |
| Revolutions of the spindles after }<br>the rollers stop..... | 300             | 312             | 325             | 337             | 349   |
| Revolutions of the spindles per }<br>draw.....               | 1,494           | 1,560           | 1,624           | 1,685           | 1,744 |
| Revolutions of the spindles per }<br>minute .....            | 7,000           | ...             | ...             | ...             | ...   |
| Produce per spindle per week.....                            | 9·253           | 7·937           | 7·038           | 6·297           | 5·679 |



## PREPARATION AND SPINNING OF HOSIERY YARN.

The following table is introduced as a guide to the practical management of hosiery yarn, showing the size of the sliver, slubbing, intermediate, roving, and counts of yarn, from 3 to 20 hanks in the pound, giving the proper draughts at every operation.

| Yarn.          | Draught. | Roving.        | Draught. | Slubbing.      | Draught. | Sliver. |
|----------------|----------|----------------|----------|----------------|----------|---------|
| 3              | 5.33     | $1\frac{1}{8}$ | 4.50     | $\frac{1}{2}$  | 4.00     | .125    |
| $3\frac{1}{2}$ | 5.60     | $1\frac{1}{4}$ | 5.00     | $\frac{1}{2}$  | 4.00     | .125    |
| 4              | 5.81     | $1\frac{3}{8}$ | 5.50     | $\frac{1}{2}$  | 4.00     | .125    |
| $4\frac{1}{2}$ | 6.00     | $1\frac{1}{2}$ | 6.00     | $\frac{1}{2}$  | 4.00     | .125    |
| 5              | 5.71     | $1\frac{3}{4}$ | 5.60     | $\frac{5}{8}$  | 5.00     | .125    |
| $5\frac{1}{2}$ | 5.86     | $1\frac{7}{8}$ | 5.00     | $\frac{3}{4}$  | 5.25     | .1428   |
| 6              | 6.00     | 2              | 5.33     | $\frac{3}{4}$  | 5.25     | .1428   |
| $6\frac{1}{2}$ | 5.71     | $2\frac{1}{4}$ | 6.00     | $\frac{3}{4}$  | 5.25     | .1428   |
| 7              | 5.89     | $2\frac{3}{8}$ | 6.00     | $\frac{7}{8}$  | 5.24     | .1666   |
| $7\frac{1}{2}$ | 6.00     | $2\frac{1}{2}$ | 5.00     | 1              | 6.00     | .1666   |
| 8              | 5.81     | $2\frac{3}{4}$ | 5.50     | 1              | 4.80     | .2083   |
| $8\frac{1}{2}$ | 5.91     | $2\frac{7}{8}$ | 5.75     | 1              | 4.80     | .2083   |
| 9              | 6.00     | 3              | 6.00     | 1              | 4.80     | .2083   |
| $9\frac{1}{2}$ | 6.08     | $3\frac{1}{8}$ | 5.55     | $1\frac{1}{8}$ | 5.40     | .2083   |
| 10             | 6.15     | $3\frac{1}{4}$ | 5.77     | $1\frac{1}{8}$ | 5.40     | .2083   |

| Yarn.           | Draught. | Roving.        | Draught. | Inter-<br>mediate. | Draught. | Slub-<br>bing. | Draught. | Sliver. |
|-----------------|----------|----------------|----------|--------------------|----------|----------------|----------|---------|
| $10\frac{1}{2}$ | 6.00     | $3\frac{1}{2}$ | 5.09     | $1\frac{3}{8}$     | 4.40     | $\frac{5}{8}$  | 4.37     | .1428   |
| 11              | 5.86     | $3\frac{3}{4}$ | 6.00     | $1\frac{1}{2}$     | 4.44     | $\frac{5}{8}$  | 4.37     | .1428   |
| $11\frac{1}{2}$ | 5.75     | 4              | 5.33     | $1\frac{1}{2}$     | 4.44     | $\frac{5}{8}$  | 4.37     | .1428   |
| 12              | 6.00     | 4              | 5.33     | $1\frac{1}{2}$     | 4.44     | $\frac{5}{8}$  | 4.37     | .1428   |
| $12\frac{1}{2}$ | 5.88     | $4\frac{1}{4}$ | 5.23     | $1\frac{5}{8}$     | 5.02     | $\frac{5}{8}$  | 4.37     | .1428   |
| 13              | 5.94     | $4\frac{3}{8}$ | 5.00     | $1\frac{3}{4}$     | 5.60     | $\frac{5}{8}$  | 4.37     | .1428   |
| $13\frac{1}{2}$ | 6.00     | $4\frac{1}{2}$ | 5.14     | $1\frac{3}{4}$     | 5.60     | $\frac{5}{8}$  | 4.37     | .1428   |
| 14              | 5.89     | $4\frac{3}{4}$ | 5.42     | $1\frac{3}{4}$     | 5.60     | $\frac{5}{8}$  | 4.37     | .1428   |
| $14\frac{1}{2}$ | 6.10     | $4\frac{3}{4}$ | 5.42     | $1\frac{3}{4}$     | 5.60     | $\frac{5}{8}$  | 4.37     | .1428   |
| 15              | 6.00     | 5              | 5.71     | $1\frac{3}{4}$     | 5.60     | $\frac{5}{8}$  | 4.37     | .1428   |
| 16              | 6.09     | $5\frac{1}{4}$ | 5.99     | $1\frac{3}{4}$     | 5.60     | $\frac{5}{8}$  | 4.37     | .1428   |
| 17              | 6.10     | $5\frac{1}{2}$ | 5.50     | 2                  | 5.33     | $\frac{3}{4}$  | 5.25     | .1428   |
| 18              | 6.00     | 6              | 5.33     | $2\frac{1}{4}$     | 6.00     | $\frac{3}{4}$  | 5.25     | .1428   |
| 19              | 6.08     | $6\frac{1}{4}$ | 5.55     | $2\frac{1}{4}$     | 6.00     | $\frac{3}{4}$  | 5.25     | .1428   |
| 20              | 6.15     | $6\frac{1}{2}$ | 5.77     | $2\frac{1}{4}$     | 6.00     | $\frac{3}{4}$  | 5.25     | .1428   |



## SLUBBING-FRAMES FOR HOSIERY YARN.

Slubbing-frame suitable for the following numbers of yarn, viz., from 3 to  $7\frac{1}{2}$  hanks in the pound. The produce is given in pounds and decimal parts of a pound, allowing 50 hours per week.

| HANKS OF YARN IN THE POUND.....                      | 3                  | $3\frac{1}{2}$ | 4             | $4\frac{1}{2}$ | 5             |
|------------------------------------------------------|--------------------|----------------|---------------|----------------|---------------|
| Hanks of slubbing in the pound...                    | $\frac{1}{2}$      | $\frac{1}{2}$  | $\frac{1}{2}$ | $\frac{1}{2}$  | $\frac{5}{8}$ |
| Twist per inch in the slubbing ...                   | ·848               | ·848           | ·848          | ·848           | ·948          |
| Decimal hank of drawing-frame) sliver .....          | ·125               | ·125           | ·125          | ·125           | ·125          |
| Draught in the rollers .....                         | 4                  | 4              | 4             | 4              | 5             |
| Diameter of the front rollers .....                  | $1\frac{1}{4}$ in. | ...            | ...           | ...            | ...           |
| Diameter of the tubes empty .....                    | $1\frac{3}{8}$ in. | ...            | ...           | ...            | ...           |
| Diameter of the bobbins when full                    | 5in.               | ...            | ...           | ...            | ...           |
| Length of the lift or traverse.....                  | 10in.              | ...            | ...           | ...            | ...           |
| Laps per inch in the traverse.....                   | 6·57               | 6·57           | 6·57          | 6·57           | 7·35          |
| Diameter of the spindles.....                        | $\frac{3}{4}$ in.  | ...            | ...           | ...            | ...           |
| Revolutions of the spindles per) minute .....        | 500                | ...            | ...           | ...            | ...           |
| Revolutions of spindles for one) of the rollers..... | 3·33               | ...            | ...           | ...            | 3·72          |
| Produce per spindle per week ...                     | 117                | ...            | ...           | ...            | 83·71         |

| HANKS OF YARN IN THE POUND.....                      | $5\frac{1}{2}$     | 6             | $6\frac{1}{2}$ | 7             | $7\frac{1}{2}$ |
|------------------------------------------------------|--------------------|---------------|----------------|---------------|----------------|
| Hanks of slubbing in the pound...                    | $\frac{3}{4}$      | $\frac{3}{4}$ | $\frac{3}{4}$  | $\frac{7}{8}$ | 1              |
| Twist per inch in the slubbing ...                   | 1·039              | 1·039         | 1·039          | 1·122         | 1·200          |
| Decimal hank of drawing-frame) sliver .....          | ·1428              | ·1428         | ·1428          | ·1666         | ·1666          |
| Draught in the rollers.....                          | 5·25               | 5·25          | 5·25           | 5·24          | 6              |
| Diameter of the front rollers .....                  | $1\frac{1}{4}$ in. | ...           | ...            | ...           | ...            |
| Diameter of the tubes empty .....                    | $1\frac{3}{8}$ in. | ...           | ...            | ...           | ...            |
| Diameter of the bobbins when full                    | 5in.               | ...           | ...            | ...           | ...            |
| Length of the lift or traverse.....                  | 10in.              | ...           | ...            | ...           | ...            |
| Laps per inch in the traverse .....                  | 8·05               | 8·05          | 8·05           | 8·69          | 9·30           |
| Diameter of the spindles.....                        | $\frac{3}{4}$ in.  | ...           | ...            | ...           | ...            |
| Revolutions of the spindles per) minute .....        | 500                | ...           | ...            | ...           | ...            |
| Revolutions of spindles for one) of the rollers..... | 4·07               | ...           | ...            | 4·40          | 4·71           |
| Produce per spindle per week ...                     | 63·65              | 63·65         | 63·65          | 50·51         | 41·33          |



## SLUBBING-FRAMES FOR HOSIERY YARN.

Slubbing-frame suitable for the following numbers of yarn, viz., from 8 to  $12\frac{1}{2}$  hanks in the pound. The produce is given in pounds and decimal parts of a pound, allowing 50 hours per week.

| HANKS OF YARN IN THE POUND.....                          | 8                  | $8\frac{1}{2}$ | 9     | $9\frac{1}{2}$ | 10             |
|----------------------------------------------------------|--------------------|----------------|-------|----------------|----------------|
| Hanks of slubbing in the pound...                        | 1                  | 1              | 1     | $1\frac{1}{8}$ | $1\frac{1}{8}$ |
| Twist per inch in the slubbing ...                       | 1·200              | 1·200          | 1·200 | 1·272          | 1·272          |
| Decimal hank of drawing-frame }<br>sliver .....          | ·2083              | ·2083          | ·2083 | ·2083          | ·2083          |
| Draught in the rollers.....                              | 4·80               | 4·80           | 4·80  | 5·40           | 5·40           |
| Diameter of the front rollers .....                      | $1\frac{1}{4}$ in. | ...            | ...   | ...            | ...            |
| Diameter of the tubes empty.....                         | $1\frac{3}{8}$ in. | ...            | ...   | ...            | ...            |
| Diameter of the bobbins full .....                       | 5in.               | ...            | ...   | ...            | ...            |
| Length of the lift or traverse .....                     | 10in.              | ...            | ...   | ...            | ...            |
| Laps per inch in the traverse.....                       | 9·30               | ...            | ...   | 9·86           | ...            |
| Diameter of the spindles... ..                           | $\frac{3}{4}$ in.  | ...            | ...   | ...            | ...            |
| Revolutions of the spindles per }<br>minute .. ..        | 500                | ...            | ...   | ...            | ...            |
| Revolutions of spindles for one }<br>of the rollers..... | 4·71               | ...            | ...   | 4·99           | 4·99           |
| Produce per spindle per week.....                        | 41·33              | ...            | ...   | 34·65          | 34·65          |

  

| HANKS OF YARN IN THE POUND.....                          | $10\frac{1}{2}$    | 11            | $11\frac{1}{2}$ | 12            | $12\frac{1}{2}$ |
|----------------------------------------------------------|--------------------|---------------|-----------------|---------------|-----------------|
| Hanks of slubbing in the pound...                        | $\frac{5}{8}$      | $\frac{5}{8}$ | $\frac{5}{8}$   | $\frac{5}{8}$ | $\frac{5}{8}$   |
| Twist per inch in the slubbing ...                       | ·949               | ...           | ...             | ...           | ...             |
| Decimal hank of drawing-frame }<br>sliver .....          | ·1428              | ...           | ...             | ...           | ...             |
| Draught in the rollers.....                              | 4·37               | 4·37          | 4·37            | 4·37          | 4·37            |
| Diameter of the front rollers .....                      | $1\frac{1}{4}$ in. | ...           | ...             | ...           | ...             |
| Diameter of the tubes empty.....                         | $1\frac{3}{8}$ in. | ...           | ...             | ...           | ...             |
| Diameter of the bobbins full .....                       | 5in.               | ...           | ...             | ...           | ...             |
| Length of the lift or traverse .....                     | 10in.              | ...           | ...             | ...           | ...             |
| Laps per inch in the traverse.....                       | 7·35               | ...           | ...             | ...           | ...             |
| Diameter of the spindles.....                            | $\frac{3}{4}$      | ...           | ...             | ...           | ...             |
| Revolutions of the spindles per }<br>minute .. ..        | 500                | ...           | ...             | ...           | ...             |
| Revolutions of spindles for one }<br>of the rollers..... | 3·72               | ...           | ...             | ...           | ...             |
| Produce per spindle per week.....                        | 83·71              | ...           | ...             | ...           | ...             |



## SLUBBING-FRAMES FOR HOSIERY YARN.

Slubbing-frames suitable for the following numbers of yarn, viz., from 13 to 20 hanks in the pound. The produce is given in pounds and decimal parts of a pound, allowing 50 hours per week.

| HANKS OF YARN IN THE POUND...                      | 13                | 13½           | 14            | 14½           | 15            |
|----------------------------------------------------|-------------------|---------------|---------------|---------------|---------------|
| Hanks of slubbing in the pound...                  | $\frac{5}{8}$     | $\frac{5}{8}$ | $\frac{5}{8}$ | $\frac{5}{8}$ | $\frac{5}{8}$ |
| Twist per inch in the roving .....                 | ·949              | ...           | ...           | ...           | ...           |
| Decimal hank drawing-frame }<br>sliver .....       | ·1428             | ...           | ...           | ...           | ...           |
| Draught in the rollers .....                       | 4·37              | ...           | ...           | ...           | ...           |
| Diameter of the front rollers .....                | 1¼in.             | ...           | ...           | ...           | ...           |
| Diameter of the tubes empty .....                  | 1⅜in.             | ...           | ...           | ...           | ...           |
| Diameter of bobbins full .....                     | 5in.              | ...           | ...           | ...           | ...           |
| Length of the lift or traverse .....               | 10in.             | ...           | ...           | ...           | ...           |
| Laps per inch in the traverse .....                | 7·35              | ...           | ...           | ...           | ...           |
| Diameter of the spindles .....                     | $\frac{3}{4}$ in. | ...           | ...           | ...           | ...           |
| Revolutions of spindles per }<br>minute .....      | 500               | ...           | ...           | ...           | ...           |
| Revolutions of spindles for one }<br>rollers ..... | 3·72              | ...           | ...           | ...           | ...           |
| Produce per spindle per week ...                   | 83·62             | ...           | ...           | ...           | ...           |

  

| HANKS OF YARN IN THE POUND...                         | 16                | 17            | 18            | 19            | 20            |
|-------------------------------------------------------|-------------------|---------------|---------------|---------------|---------------|
| Hanks of slubbing in the pound...                     | $\frac{5}{8}$     | $\frac{3}{4}$ | $\frac{3}{4}$ | $\frac{3}{4}$ | $\frac{3}{4}$ |
| Twist per inch in the slubbing ...                    | ·949              | 1·039         | 1·039         | 1·039         | 1·039         |
| Decimal hank drawing-frame }<br>sliver .....          | ·1428             | ·1428         | ·1428         | ·1428         | ·1428         |
| Draught in the rollers .....                          | 4·37              | 5·25          | 5·25          | 5·25          | 5·25          |
| Diameter of the front rollers ...                     | 1¼in.             | ...           | ...           | ...           | ...           |
| Diameter of the tubes empty .....                     | 1⅜in.             | ...           | ...           | ...           | ...           |
| Diameter of bobbins full .....                        | 5in.              | ...           | ...           | ...           | ...           |
| Length of the lift or traverse .....                  | 10in.             | ...           | ...           | ...           | ...           |
| Laps per inch in the traverse .....                   | 7·35              | 8·05          | 8·05          | 8·05          | 8·05          |
| Diameter of the spindles .....                        | $\frac{3}{4}$ in. | ...           | ...           | ...           | ...           |
| Revolutions of spindles per }<br>minute .....         | 500               | ...           | ...           | ...           | ...           |
| Revolutions of spindles for one }<br>of rollers ..... | 3·72              | 4·08          | 4·08          | 4·08          | 4·08          |
| Produce per spindle per week ...                      | 83·62             | 63·65         | 63·65         | 63·65         | 63·65         |



## INTERMEDIATE-FRAMES FOR HOSIERY YARN.

Intermediate-frame suitable for the following numbers of yarn, viz., from  $10\frac{1}{2}$  to 15 hanks in the pound. The produce is given in pounds and decimal parts of a pound, allowing 51 hours per week.

| HANKS OF YARN IN THE POUND...                         | $10\frac{1}{2}$     | 11             | $11\frac{1}{2}$ | 12             | $12\frac{1}{2}$ |
|-------------------------------------------------------|---------------------|----------------|-----------------|----------------|-----------------|
| Hanks of intermediate roving.....                     | $1\frac{3}{8}$      | $1\frac{1}{2}$ | $1\frac{1}{2}$  | $1\frac{1}{2}$ | $1\frac{5}{8}$  |
| Twist per inch in the roving .....                    | 1.407               | 1.469          | 1.469           | 1.469          | 1.529           |
| Slubbing roving put up double ...                     | $\frac{5}{8}$       | $\frac{5}{8}$  | $\frac{5}{8}$   | $\frac{5}{8}$  | $\frac{5}{8}$   |
| Draught in the rollers.....                           | 4.40                | 4.44           | 4.44            | 4.44           | 5.02            |
| Diameter of the front rollers .....                   | $1\frac{1}{8}$ in.  | ...            | ...             | ...            | ...             |
| Diameter of the tubes empty.....                      | $1\frac{1}{4}$ in.  | ...            | ...             | ...            | ...             |
| Diameter of the bobbins full .....                    | 4in.                | ...            | ...             | ...            | ...             |
| Length of the lift or traverse.....                   | 8in.                | ...            | ...             | ...            | ...             |
| Laps per inch in the traverse.....                    | 10.80               | 11.38          | 11.38           | 11.38          | 11.85           |
| Diameter of the spindles.....                         | $\frac{23}{32}$ in. | ...            | ...             | ...            | ...             |
| Revolutions of spindles per }<br>minute .....         | 677                 | ...            | ...             | ...            | ...             |
| Revolutions of spindles for one }<br>of rollers ..... | 4.98                | 5.20           | 5.20            | 5.20           | 5.42            |
| Produce per spindle per week ...                      | 34.90               | 31.08          | 31.08           | 31.08          | 27.57           |

  

| HANKS OF YARN IN THE POUND...                         | 13                  | $13\frac{1}{2}$ | 14             | $14\frac{1}{2}$ | 15             |
|-------------------------------------------------------|---------------------|-----------------|----------------|-----------------|----------------|
| Hanks of intermediate roving.....                     | $1\frac{3}{4}$      | $1\frac{3}{4}$  | $1\frac{3}{4}$ | $1\frac{3}{4}$  | $1\frac{3}{4}$ |
| Twist per inch in the roving .....                    | 1.587               | 1.587           | 1.587          | 1.587           | 1.587          |
| Slubbing roving put up double ...                     | $\frac{5}{8}$       | ...             | ...            | ...             | ...            |
| Draught in the rollers .....                          | 5.60                | ...             | ...            | ...             | ...            |
| Diameter of the front rollers .....                   | $1\frac{1}{8}$ in.  | ...             | ...            | ...             | ...            |
| Diameter of the tubes empty.....                      | $1\frac{1}{4}$ in.  | ...             | ...            | ...             | ...            |
| Diameter of the bobbins full .....                    | 4in.                | ...             | ...            | ...             | ...            |
| Length of the lift or traverse .....                  | 8in.                | ...             | ...            | ...             | ...            |
| Laps per inch in the traverse.....                    | 12.30               | ...             | ...            | ...             | ...            |
| Diameter of the spindles.....                         | $\frac{23}{32}$ in. | ...             | ...            | ...             | ...            |
| Revolutions of spindles per }<br>minute .....         | 677                 | ...             | ...            | ...             | ...            |
| Revolutions of spindles for one }<br>of rollers ..... | 6.04                | ...             | ...            | ...             | ...            |
| Produce per spindle per week ...                      | 25.37               | ...             | ...            | ...             | ...            |



## INTERMEDIATE-FRAME FOR HOSIERY YARN.

Intermediate-frame suitable for the following numbers of yarn, viz., from 16 to 20 hanks in the pound. The produce is given in pounds and decimal parts of a pound, allowing 51 hours per week.

| HANKS OF YARN IN THE POUND...         | 16                                      | 17            | 18             | 19             | 20             |
|---------------------------------------|-----------------------------------------|---------------|----------------|----------------|----------------|
| Hanks of intermediate roving ...      | $1\frac{3}{4}$                          | 2             | $2\frac{1}{4}$ | $2\frac{1}{4}$ | $2\frac{1}{4}$ |
| Twist per inch in the roving .....    | 1.587                                   | 1.697         | 1.800          | 1.800          | 1.800          |
| Slubbing roving put up double ...     | $\frac{5}{8}$                           | $\frac{3}{4}$ | $\frac{3}{4}$  | $\frac{3}{4}$  | $\frac{3}{4}$  |
| Draught in the rollers .....          | 5.60                                    | 5.33          | 6              | 6              | 6              |
| Diameter of the front rollers.....    | $1\frac{1}{8}$ in.                      | ...           | ...            | ...            | ...            |
| Diameter of the tubes empty ...       | $1\frac{1}{4}$ in.                      | ...           | ...            | ...            | ...            |
| Diameter of the bobbins full.....     | 4in.                                    | ...           | ...            | ...            | ...            |
| Length of the lift or traverse ...    | 8in.                                    | ...           | ...            | ...            | ...            |
| Laps per inch in the traverse.....    | 12.30                                   | 13.15         | 13.95          | 13.95          | 13.95          |
| Diameter of the spindles .....        | $\frac{2\frac{3}{4}}{3\frac{1}{2}}$ in. | ...           | ...            | ...            | ...            |
| Revolutions of spindles per minute    | 677                                     | ...           | ...            | ...            | ...            |
| Do. of spindles for one of rollers... | 5.60                                    | 5.99          | 6.36           | 6.36           | 6.36           |
| Produce per spindle per week ...      | 24.66                                   | 21.75         | 16.91          | 16.91          | 16.91          |

## FINE ROVING-FRAME FOR HOSIERY YARN.

Roving-frames suitable for the following numbers of yarn, viz., from 3 to 5 hanks in the pound, allowing 52 hours per week.

| HANKS OF YARN IN THE POUND...         | 3                                       | $3\frac{1}{2}$ | 4              | $4\frac{1}{2}$ | 5              |
|---------------------------------------|-----------------------------------------|----------------|----------------|----------------|----------------|
| Hanks of roving in the pound ...      | $1\frac{1}{8}$                          | $1\frac{1}{4}$ | $1\frac{3}{8}$ | $1\frac{1}{2}$ | $1\frac{3}{4}$ |
| Twist per inch in the roving .....    | 1.272                                   | 1.340          | 1.407          | 1.469          | 1.587          |
| Slubbing roving put up double ...     | $\frac{1}{2}$                           | $\frac{1}{2}$  | $\frac{1}{2}$  | $\frac{1}{2}$  | $\frac{5}{8}$  |
| Draught in the rollers .....          | 4.50                                    | 5              | 5              | 5              | 5              |
| Diameter of the front rollers.....    | $1\frac{1}{8}$ in.                      | ...            | ...            | ...            | ...            |
| Diameter of the tubes empty ...       | $1\frac{3}{16}$ in.                     | ...            | ...            | ...            | ...            |
| Diameter of the bobbins full.....     | $3\frac{1}{2}$ in.                      | ...            | ...            | ...            | ...            |
| Length of the lift or traverse ...    | 7in.                                    | ...            | ...            | ...            | ...            |
| Laps per inch in the traverse ...     | 9.863                                   | 10.39          | 10.80          | 11.38          | 12.30          |
| Diameter of the spindles .....        | $\frac{1\frac{1}{8}}{1\frac{1}{6}}$ in. | ...            | ...            | ...            | ...            |
| Revolutions of spindles per minute    | 750                                     | ...            | ...            | ...            | ...            |
| Do. of spindles for one of rollers... | 4.49                                    | 4.73           | 4.97           | 5.19           | 5.60           |
| Produce per spindle per week ...      | 54.05                                   | 46.17          | 39.99          | 35.11          | 27.86          |



## FINE ROVING-FRAMES FOR HOSIERY YARN.

Roving-frames suitable for the following numbers of yarn, viz., from  $5\frac{1}{2}$  to 10 hanks in the pound. The produce is given in pounds and decimal parts of a pound, allowing 52 hours per week.

| HANKS OF YARN IN THE POUND...                         | $5\frac{1}{2}$      | 6             | $6\frac{1}{2}$ | 7              | $7\frac{1}{2}$ |
|-------------------------------------------------------|---------------------|---------------|----------------|----------------|----------------|
| Hanks of roving in the pound ...                      | $1\frac{7}{8}$      | 2             | $2\frac{1}{4}$ | $2\frac{3}{8}$ | $2\frac{1}{2}$ |
| Twist per inch in the roving .....                    | 1.643               | 1.697         | 1.800          | 1.849          | 1.897          |
| Slubbing roving put up double ...                     | $\frac{3}{4}$       | $\frac{3}{4}$ | $\frac{3}{4}$  | $\frac{7}{8}$  | 1              |
| Draught in the rollers .....                          | 5                   | 5.33          | 6              | 6              | 5              |
| Diameter of the front rollers.....                    | $1\frac{1}{8}$ in.  | ...           | ...            | ...            | ...            |
| Diameter of the tubes empty ...                       | $1\frac{3}{16}$ in. | ...           | ...            | ...            | ...            |
| Diameter of the bobbins full.....                     | $3\frac{1}{2}$ in.  | ...           | ...            | ...            | ...            |
| Length of the lift or traverse ...                    | 7in.                | ...           | ...            | ...            | ...            |
| Laps per inch in the traverse.....                    | 12.73               | 13.15         | 13.95          | 14.33          | 14.70          |
| Diameter of the spindles .....                        | $\frac{11}{16}$ in. | ...           | ...            | ...            | ...            |
| Revolutions of spindles per }<br>minute .....         | 750                 | ...           | ...            | ...            | ...            |
| Revolutions of spindles for one }<br>of rollers ..... | 5.80                | 5.99          | 6.36           | 6.53           | 6.70           |
| Produce per spindle per week ...                      | 25.12               | 22.36         | 18.23          | 17.62          | 16             |

  

| HANKS OF YARN IN THE POUND...                         | 8                   | $8\frac{1}{2}$ | 9     | $9\frac{1}{2}$ | 10             |
|-------------------------------------------------------|---------------------|----------------|-------|----------------|----------------|
| Hanks of roving in the pound ...                      | $2\frac{3}{4}$      | $2\frac{7}{8}$ | 3     | $3\frac{1}{8}$ | $3\frac{1}{4}$ |
| Twist per inch in the roving .....                    | 1.989               | 2.034          | 2.078 | 2.121          | 2.163          |
| Slubbing roving put up double ...                     | 1                   | 1              | 1     | $1\frac{1}{8}$ | $1\frac{1}{8}$ |
| Draught in the rollers .....                          | 5.50                | 5.75           | 6     | 5.55           | 5.77           |
| Diameter of the front rollers.....                    | $1\frac{1}{8}$ in.  | ...            | ...   | ...            | ...            |
| Diameter of the tubes empty.....                      | $1\frac{3}{16}$ in. | ...            | ...   | ...            | ...            |
| Diameter of the bobbins full.....                     | $3\frac{1}{2}$ in.  | ...            | ...   | ...            | ...            |
| Length of the lift or traverse ...                    | 7in.                | ...            | ...   | ...            | ...            |
| Laps per inch in the traverse ...                     | 15.42               | 15.76          | 16.10 | 16.44          | 16.76          |
| Diameter of the spindles .....                        | $\frac{11}{16}$ in. | ...            | ...   | ...            | ...            |
| Revolutions of spindles per }<br>minute .....         | 750                 | ...            | ...   | ...            | ...            |
| Revolutions of spindles for one }<br>of rollers ..... | 7.02                | 7.18           | 7.34  | 7.49           | 7.64           |
| Produce per spindle per week ...                      | 14.14               | 13.23          | 12.41 | 11.67          | 11             |



FINE ROVING-FRAMES FOR HOSIERY YARN.

Roving-frames suitable for the following numbers of yarn, viz., from 10½ to 15 hanks in the pound. The produce is given in pounds and decimal parts of a pound, allowing 52 hours per week.

| HANKS OF YARN IN THE POUND...                        | 10½   | 11    | 11½   | 12    | 12½   |
|------------------------------------------------------|-------|-------|-------|-------|-------|
| Hanks of roving in the pound ...                     | 3½    | 3¾    | 4     | 4     | 4¼    |
| Twist per inch in the roving .....                   | 2·244 | 2·323 | 2·400 | 2·400 | 2·473 |
| Intermediate roving put up }<br>double .....         | 1¾    | 1½    | 1½    | 1½    | 1⅝    |
| Draught in the rollers .....                         | 5·09  | 5     | 5·33  | 5·33  | 5·23  |
| Diameter of the front rollers .....                  | 1⅛in. | ...   | ...   | ...   | ...   |
| Diameter of the tubes empty ...                      | 1⅜in. | ...   | ...   | ...   | ...   |
| Diameter of bobbins full .....                       | 3½in. | ...   | ...   | ...   | ...   |
| Length of lift or traverse .....                     | 7in.  | ...   | ...   | ...   | ...   |
| Laps per inch in the traverse ...                    | 17·39 | 18    | 18·60 | 18·60 | 19·16 |
| Diameter of the spindles .....                       | 1⅞in. | ...   | ...   | ...   | ...   |
| Revolutions of spindles per }<br>minute .....        | 750   | ...   | ...   | ...   | ...   |
| Revolutions of spindles for one }<br>of rollers..... | 7·89  | 8·18  | 8·58  | 8·58  | 8·71  |
| Produce per spindle per week ...                     | 9·852 | 8·882 | 8·060 | 8·060 | 7·360 |

| HANKS OF YARN IN THE POUND...                        | 13    | 13½   | 14    | 14½   | 15    |
|------------------------------------------------------|-------|-------|-------|-------|-------|
| Hanks of roving in the pound ...                     | 4¾    | 4½    | 4¾    | 4¾    | 5     |
| Twist per inch in the roving .....                   | 2·509 | 2·545 | 2·615 | 2·615 | 2·683 |
| Intermediate roving put up }<br>double .....         | 1¾    | 1¾    | 1¾    | 1¾    | 1¾    |
| Draught in the rollers .....                         | 5     | 5·14  | 5·42  | 5·42  | 5·71  |
| Diameter of the front rollers.....                   | 1⅛in. | ...   | ...   | ...   | ...   |
| Diameter of the tubes empty.....                     | 1⅜in. | ...   | ...   | ...   | ...   |
| Diameter of bobbins full .....                       | 3½in. | ...   | ...   | ...   | ...   |
| Length of lift or traverse .....                     | 7in.  | ...   | ...   | ...   | ...   |
| Laps per inch in the traverse.....                   | 19·44 | 19·72 | 20·26 | 20·26 | 20·79 |
| Diameter of the spindles .....                       | 1⅞in. | ...   | ...   | ...   | ...   |
| Revolutions of spindles per }<br>minute .....        | 750   | ...   | ...   | ...   | ...   |
| Revolutions of spindles for one }<br>of rollers..... | 8·86  | 8·96  | 9·20  | 9·20  | 9·48  |
| Produce per spindle per week ...                     | 7·049 | 6·756 | 6·232 | 6·232 | 5·768 |



## FINE ROVING-FRAMES FOR HOSIERY YARN.

Roving-frames suitable for the following numbers of yarn, viz., from 16 to 20 hanks in the pound. The produce is given in pounds and decimal parts of a pound, allowing 52 hours per week.

| HANKS OF YARN IN THE POUND...                         | 16                 | 17             | 18             | 19             | 20             |
|-------------------------------------------------------|--------------------|----------------|----------------|----------------|----------------|
| Hanks of roving in the pound ...                      | $5\frac{1}{4}$     | $5\frac{1}{2}$ | 6              | $6\frac{1}{4}$ | $6\frac{1}{2}$ |
| Twist per inch in the roving .....                    | 2·749              | 2·814          | 2·939          | 3              | 3·059          |
| Intermediate roving put up }<br>double .....          | $1\frac{3}{4}$     | 2              | $2\frac{1}{4}$ | $2\frac{1}{4}$ | $2\frac{1}{4}$ |
| Draught in the rollers .....                          | 6·09               | 6·10           | 6              | 6·08           | 6·15           |
| Diameter of the front rollers.....                    | $1\frac{1}{8}$ in. | ...            | ...            | ...            | ...            |
| Diameter of the tubes empty.....                      | $1\frac{1}{8}$ in. | ...            | ...            | ...            | ...            |
| Diameter of the bobbins full.....                     | 3in.               | ...            | ...            | ...            | ...            |
| Length of the lift or traverse ...                    | 6in.               | ...            | ...            | ...            | ...            |
| Laps per inch in the traverse ...                     | 21·30              | 21·81          | 22·78          | 23·25          | 23·71          |
| Diameter of the spindles .....                        | $\frac{5}{8}$ in.  | ...            | ...            | ...            | ...            |
| Revolutions of spindles per }<br>minute .....         | 893                | ...            | ...            | ...            | ...            |
| Revolutions of spindles for one }<br>of rollers ..... | 9·71               | 9·93           | 10·35          | 10·60          | 10·77          |
| Produce per spindle per week ...                      | 6·38               | 5·93           | 5·21           | 4·91           | 4·63           |

## HOSIERY YARN.

In spinning hosiery yarn provision should be made for altering the speed of the spindles according to the speed laid down in the tables, which will be found as quick as can be followed by the minder and piecers. The speeds are so calculated as to spin a draw or length in the same time as 20's weft, and will produce 44 hanks per spindle per week. The length spun of all numbers are alike; that is, a draw is spun in the same time, whatever the counts may be. The counts or numbers most commonly called for are 5's,  $5\frac{1}{2}$ 's, 6's,  $6\frac{1}{2}$ 's, and 7's. To those never having been in this branch of spinning I would advise very great caution respecting the colour or tinge, which must be either white or a light cream colour. They are named by the tie, such as white tie, and orange tie. These colours should always be kept apart, as they show themselves very distinctly in the stockings. It requires great care in keeping the colours always of the same shade.



## MULE SPINNING.—HOSIERY YARN.

For spinning hosiery yarn on mules of the following numbers, viz., from 3 to 10 hanks in the pound. The produce per week is derived from supposing the mules to work 58 hours per week, and allowing  $7\frac{1}{2}$  per cent for time lost in winding on the yarn, doffing the cops, and other stoppages. The produce is given in pounds and decimal parts of a pound.

| HANKS OF YARN IN THE POUND...       | 3              | $3\frac{1}{2}$ | 4              | $4\frac{1}{2}$ | 5              |
|-------------------------------------|----------------|----------------|----------------|----------------|----------------|
| Twist per inch in the yarn.....     | 4.33           | 4.74           | 5              | 5.30           | 5.59           |
| Hank roving put up double .....     | $1\frac{1}{8}$ | $1\frac{1}{4}$ | $1\frac{3}{8}$ | $1\frac{1}{2}$ | $1\frac{3}{4}$ |
| Draught in the rollers.....         | 5.33           | 5.60           | 5.81           | 6              | 5.71           |
| Traverse of the carriage in inches. | 64             | 64             | 64             | 64             | 64             |
| Revolutions of spindles per draw..  | 277            | 303            | 320            | 339            | 357            |
| Revolutions of spindles per minute  | 1,794          | 1,961          | 2,070          | 2,204          | 2,312          |
| Produce per spindle per week.....   | 14.70          | 12.58          | 11.01          | 9.805          | 8.795          |

| HANKS OF YARN IN THE POUND...       | $5\frac{1}{2}$ | 6     | $6\frac{1}{2}$ | 7              | $7\frac{1}{2}$ |
|-------------------------------------|----------------|-------|----------------|----------------|----------------|
| Twist per inch in the yarn.....     | 5.86           | 6.12  | 6.37           | 6.61           | 6.84           |
| Hank roving put up double .....     | $1\frac{7}{8}$ | 2     | $2\frac{1}{4}$ | $2\frac{3}{8}$ | $2\frac{1}{2}$ |
| Draught in the rollers.....         | 5.86           | 6     | 5.77           | 5.89           | 6              |
| Traverse of the carriage in inches. | 64             | 64    | 64             | 64             | 64             |
| Revolutions of spindles per draw..  | 375            | 391   | 407            | 423            | 437            |
| Revolutions of spindles per minute  | 2,428          | 2,532 | 2,635          | 2,752          | 2,830          |
| Produce per spindle per week.....   | 7.999          | 7.370 | 6.771          | 6.330          | 5.871          |

| HANKS OF YARN IN THE POUND...       | 8              | $8\frac{1}{2}$ | 9     | $9\frac{1}{2}$ | 10             |
|-------------------------------------|----------------|----------------|-------|----------------|----------------|
| Twist per inch in the yarn.....     | 7.07           | 7.28           | 7.50  | 7.70           | 7.90           |
| Hank roving put up double .....     | $2\frac{3}{4}$ | $2\frac{7}{8}$ | 3     | $3\frac{1}{8}$ | $3\frac{1}{4}$ |
| Draught in the rollers.....         | 5.81           | 5.91           | 6     | 6.08           | 6.15           |
| Traverse of the carriage in inches. | 64             | 64             | 64    | 64             | 64             |
| Revolutions of spindles per draw..  | 452            | 466            | 480   | 492            | 505            |
| Revolutions of spindles per minute  | 2,926          | 3,017          | 3,108 | 3,175          | 3,270          |
| Produce per spindle per week.....   | 5.507          | 5.190          | 4.901 | 4.710          | 4.406          |



## MULE SPINNING—HOSIERY YARN.

For spinning hosiery yarn on mules of the following numbers, viz., from  $10\frac{1}{2}$  to 20 hanks in the pound. The produce per week is derived from supposing the mules to work 58 hours per week, and allowing  $7\frac{1}{2}$  per cent for time lost in winding on the yarn, doffing the cops, and other stoppages. The produce is given in pounds and decimal parts of a pound.

| HANKS OF YARN IN THE POUND...       | $10\frac{1}{2}$ | 11              | $11\frac{1}{2}$ | 12              | $12\frac{1}{2}$ |
|-------------------------------------|-----------------|-----------------|-----------------|-----------------|-----------------|
| Twist per inch in the yarn.....     | 8.10            | 8.29            | 8.47            | 8.66            | 8.83            |
| Hank roving put up double .....     | $3\frac{1}{2}$  | $3\frac{3}{4}$  | 4               | 4               | $4\frac{1}{4}$  |
| Draught in the rollers.....         | 6               | 5.86            | 5.75            | 6               | 5.88            |
| Traverse of the carriage in inches. | 64              | 64              | 64              | 64              | 64              |
| Revolutions of spindles per draw..  | 518             | 530             | 542             | 554             | 565             |
| Revolutions of spindles per minute  | 3,354           | 3,432           | 3,515           | 3,587           | 3,658           |
| Produce per spindle per week.....   | 4.197           | 4.006           | 3.841           | 3.674           | 3.529           |
| HANKS OF YARN IN THE POUND...       | 13              | $13\frac{1}{2}$ | 14              | $14\frac{1}{2}$ | 15              |
| Twist per inch in the yarn.....     | 9.01            | 9.18            | 9.35            | 9.52            | 9.68            |
| Hank roving put up double .....     | $4\frac{3}{8}$  | $4\frac{1}{2}$  | $4\frac{3}{4}$  | $4\frac{3}{4}$  | 5               |
| Draught in the rollers.....         | 5.94            | 6               | 5.89            | 6.10            | 6               |
| Traverse of the carriage in inches. | 64              | 64              | 64              | 64              | 64              |
| Revolutions of spindles per draw..  | 576             | 587             | 598             | 609             | 619             |
| Revolutions of spindles per minute  | 3,730           | 3,801           | 3,872           | 3,943           | 4,008           |
| Produce per spindle per week.....   | 3.389           | 3.264           | 3.148           | 3.040           | 2.938           |
| HANKS OF YARN IN THE POUND...       | 16              | 17              | 18              | 19              | 20              |
| Twist per inch in the yarn.....     | 10              | 10.30           | 10.60           | 10.89           | 11.18           |
| Hank roving put up double .....     | $5\frac{1}{4}$  | $5\frac{1}{2}$  | 6               | $6\frac{1}{4}$  | $6\frac{1}{2}$  |
| Draught in the rollers.....         | 6.09            | 6.10            | 6               | 6.08            | 6.15            |
| Traverse of the carriage in inches. | 64              | 64              | 64              | 64              | 64              |
| Revolutions of spindles per draw..  | 640             | 659             | 678             | 697             | 715             |
| Revolutions of spindles per minute  | 4,144           | 4,266           | 4,390           | 4,513           | 4,630           |
| Produce per spindle per week.....   | 2.757           | 2.593           | 2.449           | 2.321           | 2.204           |



EQUAL TO ONE-HORSE POWER.

In the following table is given the number of spinning spindles equal to one-horse power, with and without preparations, supposing the spindles to make 7,000 revolutions per minute.

| Counts of Yarn. |       | Spindles with Preparations. | Spindles without Preparations. | One-horse power. |
|-----------------|-------|-----------------------------|--------------------------------|------------------|
| Spinning        | 10's  | 380                         | 980                            | 1                |
| "               | 20's  | 428                         | 985                            | 1                |
| "               | 30's  | 458                         | 990                            | 1                |
| "               | 40's  | 480                         | 995                            | 1                |
| "               | 50's  | 500                         | 1000                           | 1                |
| "               | 60's  | 514                         | 1005                           | 1                |
| "               | 70's  | 526                         | 1010                           | 1                |
| "               | 80's  | 540                         | 1015                           | 1                |
| "               | 90's  | 550                         | 1020                           | 1                |
| "               | 100's | 560                         | 1025                           | 1                |
| "               | 120's | 577                         | 1030                           | 1                |
| "               | 140's | 592                         | 1035                           | 1                |
| "               | 160's | 605                         | 1040                           | 1                |
| "               | 180's | 615                         | 1045                           | 1                |
| "               | 200's | 628                         | 1050                           | 1                |
| "               | 220's | 638                         | 1055                           | 1                |
| "               | 240's | 648                         | 1060                           | 1                |
| "               | 260's | 658                         | 1065                           | 1                |
| "               | 280's | 665                         | 1070                           | 1                |
| "               | 300's | 672                         | 1075                           | 1                |
| "               | 320's | 680                         | 1080                           | 1                |
| "               | 340's | 686                         | 1085                           | 1                |
| "               | 350's | 690                         | 1088                           | 1                |

|     |                                      |                  |
|-----|--------------------------------------|------------------|
| 27½ | cubic feet of boiler room            | = 1-horse power. |
| 5   | square feet of water surface         | = 1 "            |
| 12  | superficial feet of heating surface  | = 1 "            |
| ¾   | feet of grate bars                   | = 1 "            |
| 28  | in. area steam cylinder low pressure | = 1 "            |



## TO FIND THE SPEED PER MINUTE OF ANY GIVEN SHAFT.

*Rule.*—Begin at the first motion shaft and trace out all the driving and all the driven wheels separately. Multiply all the driving wheels together and their product by the speed per minute of the first shaft, then multiply all the driven wheels together, including the first driven wheel on the given shaft (the speed of which we wish to ascertain); divide the product of the drivers by the product of the driven and the result thus obtained will be the speed of the given shaft.

## EXAMPLES.

The fly spur wheel of a steam engine contains 232 teeth, and makes 25 revolutions per minute. How many revolutions per minute will the second motion shaft make with a driven wheel of 58 teeth?

Number of teeth in fly spur wheel 232; second motion 58 teeth.  
Speed of the fly spur wheel 25

---

1160  
464

---

Second motion wheel 58)5800(100 revolutions of the  
58 second motion shaft.  
00

---

If the driving bevel wheel on the second motion shaft contains 61 teeth, and the driven bevel wheel on the bottom of the upright shaft contains 47 teeth, how many revolutions per minute will the upright shaft make?

Driving wheels  $232 \times 61 \times 25 = 353800$  = 129.787, speed of  
Driven wheels  $58 \times 47 = 2726$  upright shaft.

If the driving bevel wheel on the upright shaft contains 58 teeth, and the driven wheels on the line shafts 47 teeth, how many revolutions per minute will the line shafts make?

Drivers  $232 \times 61 \times 58 \times 25 = 20520400$  = 160.1645 revolutions per  
Driven  $58 \times 47 \times 47 = 128122$  min. of line shafts.

## COTTON OPENER.

If the beater of the cotton opener be 24 inches diameter its speed should be about 1,000 revolutions per minute. The speed of the line shaft being 160 revolutions per minute with a driving drum of 36 inches diameter, driving the fast and loose pulleys on



the counter or speed shaft of 17 inches diameter, and the driving drum on the same shaft of 36 inches diameter, driving a pulley on the beater shaft of 12 inches diameter, what will be the speed of the beater?

$$\begin{array}{l} \text{Drivers } 160 \times 36 \times 36 = 207360 \\ \text{Driven } \frac{17 \times 12}{204} = 1011 \text{ revolutions of the beater} \\ \text{per minute.} \end{array}$$

### SPREADING MACHINE.

If the beater of a spreading machine be 18 inches diameter, its speed should be about 1,360 revolutions per minute. The speed of the line shaft being 160 revolutions per minute with a driving drum of 36 inches diameter, driving the fast and loose pullies on the counter or speed shaft of 16 inches diameter, and the driving drum on the same shaft of 36 inches diameter, driving a pulley on the beater shaft of  $9\frac{1}{2}$  inches diameter, what will be the speed of the beater?

$$\begin{array}{l} \text{Drivers } 160 \times 36 \times 36 = 207360 \\ \text{Driven } \frac{16 \times 9\frac{1}{2}}{152} = 1364 \text{ revolutions of the beater} \\ \text{per minute.} \end{array}$$

### DOUBLING MACHINE.

If 40's finisher carding-engines, 36 inches wide on the wire, require 2,338 pounds of feed laps from the doubling machine per week, how many revolutions per minute will the calender rollers of 8 inches diameter have to make to supply them, one yard of feed to weigh 8 ounces, the machine working 45 hours per week?

$$\begin{array}{l} \text{lb.} \quad \text{yd.} \quad \text{in.} \quad \text{min.} \\ 12338 \times 2 = 24676 \times 36 = 888336 \div 2700 = 329 \text{ inches per minute.} \end{array}$$

Divide the inches per minute by the circumference of the calender rollers, the diameter being 8 inches multiplied by  $3.1416 = 25.1328$  inches circumference.

$$\begin{array}{l} \text{Inches per minute } \frac{329.0000}{25.1328} = 13.09 \text{ revolutions of calender rollers} \\ \text{per minute.} \end{array}$$

### CALCULATION OF SPEED.

The speed of the line shaft being 160 revolutions per minute, what pullies and wheels will be suitable to bring out the revolutions required? The first driving drum on the line shaft is 6 inches diameter, driving the fast and loose pullies on the cross shaft of the doubling machine of 30 inches diameter, 2 pinions of 18 teeth each on the same shaft, driving two wheels on the calender and lapping rollers of 44 teeth each.

$$\begin{array}{l} \text{Drivers } 160 \times 6 \times 18 = 17280 \\ \text{Driven } \frac{44 \times 30}{1320} = 13.09 \text{ revolutions of the rollers per} \\ \text{minute.} \end{array}$$



## CARDING-ENGINES.

If the main cylinder of a carding-engine be required to make 140 revolutions per minute with pullies of 14 inches diameter, what size of drum will be required on the line shaft making 160 revolutions per minute?

$$\frac{\text{Drivers } 140 \times 14 = 1960}{\text{Driven } 160} = 12.25, \text{ or } 12\frac{1}{4} \text{ inches drum.}$$

And *vice versa*, if a drum on the line shaft of  $12\frac{1}{4}$  inches diameter, and making 160 revolutions per minute, what will be the diameter of the pullies of the main cylinder to give 140 revolutions per minute?

$$\frac{\text{Drivers } 160 \times 12\frac{1}{4} = 1960}{140} = 14 \text{ inches diameter of the pullies.}$$

## DRAWING-FRAME.

The speed of the line shaft being 160 revolutions per minute, with a driving drum of 14 inches diameter, and supposing the front rollers of a drawing frame are required to make 330 revolutions per minute, with fast and loose pullies of 8 inches diameter, and driven by drums on the frame shaft of 16 inches diameter, what will be the size of the pulley on the end of the frame shaft to bring out the required speed?

$$\frac{\text{Drivers } 160 \times 14 \times 16 = 35840}{\text{Driven } 330 \times 8 = 2640} = 13.575, \text{ or say } 13\frac{1}{2} \text{ inches diameter.}$$

## SLUBBING-FRAMES.

From the following particulars find the speed of the spindles of a slubbing-frame. The line shaft driving drum of 14 inches diameter makes 160 revolutions per minute, driven pullies on the frame shaft 12 inches diameter, driving wheel on the frame shaft of 57 teeth, driven wheel on the spindle shaft of 44 teeth, driving bevel wheels on the spindle shafts of 60 teeth, and the spindle wheels 29 teeth.

$$\frac{\text{Drivers } 160 \times 14 \times 37 \times 60 = 7660800}{\text{Driven } 12 \times 44 \times 29 = 15312} = 500 \text{ revolutions per min.}$$

## INTERMEDIATE-FRAME.

From the following particulars find the speed of the spindles of an intermediate-frame. The line shaft driving drum of 18 inches diameter makes 160 revolutions per minute, driven pullies on the frame shaft 12 inches diameter, driving wheel on the frame shaft of 60 teeth, driven wheel on the spindle shaft of 44 teeth, driving



bevel wheels on the spindle shaft of 60 teeth, and the spindle wheels 29 teeth.

$$\begin{array}{l} \text{Drivers } 160 \times 18 \times 60 \times 60 = 10368000 \\ \text{Driven } \frac{12 \times 44 \times 29}{15312} = 677 \end{array} \quad \begin{array}{l} \text{revolutions of the} \\ \text{spindles per minute.} \end{array}$$

### ROVING-FRAME.

From the following particulars find the speed of the spindles of a roving-frame. The line shaft driving drum of 24 inches diameter makes 160 revolutions per minute, driven pulleys on the frame shaft 12 inches diameter, driving wheel on the frame shaft of 60 teeth, driven wheel on the spindle shaft of 44 teeth, driving bevel wheels on the spindle shaft of 60 teeth, and spindle wheels of 29 teeth.

$$\begin{array}{l} \text{Drivers } 160 \times 24 \times 60 \times 60 = 13824000 \\ \text{Driven } \frac{12 \times 44 \times 29}{15312} = 902 \end{array} \quad \begin{array}{l} \text{revolutions of the} \\ \text{spindles per minute.} \end{array}$$

### SELF-ACTING MULE OR JENNY.

From the following particulars find the revolutions per minute of the spindles of a mule or jenny. The driving drum of the line shaft is 36 inches diameter and makes 160 revolutions per minute, the fast and loose pulleys and drum of the top speed shaft are equal in diameter, viz., 17 inches, the drum driving the fast and loose pulleys on the rim pulley shaft of 16 inches diameter; the rim pulley of 24 inches diameter drives a pulley on the drum shaft (in the carriage) of  $15\frac{1}{4}$  inches diameter; as the bevel wheels for driving the drums in the carriage are generally of the same number of teeth they are not taken into account, neither are the top speed pulleys and drum; the tin drums are 14 inches diameter and the spindle warves  $1\frac{1}{8}$  inch diameter.

$$\begin{array}{l} \text{Drivers } 160 \times 36 \times 24 \times 14 = 19353600 \\ \text{Driven } \frac{16 \times 15\frac{1}{4} \times 1\frac{1}{8}}{2745} = 7050 \end{array} \quad \begin{array}{l} \text{revolutions of} \\ \text{spindles per minute.} \end{array}$$

### CALCULATION OF DRAUGHTS—DRAWING-FRAME.

A drawing-frame with three lines of rollers putting six ends into one will have two places for draught; the square root of the whole draught will give the quantity of draught to each place.

A drawing-frame with four lines of rollers and putting eight ends into one will have three places for draught, and the cube root of the whole draught will give the draught of each of the three separate places, but it sometimes may happen that an equal quantity of draught cannot be obtained, in consequence of having to be governed by a tooth in the gearing, more or less. In such cases let the greater draught be towards the front rollers.

From the following particulars of a drawing-frame with three lines of rollers and putting six ends into one, what will be the



draught? The front rollers are  $1\frac{3}{8}$  inch diameter with a pinion of 27 teeth, driving a double carrier wheel of 57 teeth, and a pinion on the double carrier of 27 teeth, driving the back roller wheel of 56 teeth, the back roller one inch diameter.

For a dividend  $56 \times 57 \times 1\frac{3}{8} = 4389$

For a divisor  $27 \times 27 \times 1 = 729 = 6.0205$ , the whole draught.

To divide the draught equally between the front and back, find the square root of the whole draught, which will be 2.45367, equal draught for front and back.

From the following particulars what will be the draught between the front and middle rollers? The front rollers are  $1\frac{3}{8}$  inch diameter, the middle rollers are one inch diameter, the front roller pinion of 27, and the double carrier pinion of 26 teeth, the back roller wheel 36, and the double carrier wheel 35 teeth.

For a dividend  $36 \times 35 \times 1\frac{3}{8} = 1732.5 = 2.4679$ , the front

For a divisor  $27 \times 26 \times 1 = 702 =$  draught.

Then  $6.0205 \div 2.4679 = 2.4395 =$  the back draught.

By multiplying the front by the back draught will give the whole draught nearly.

Thus  $2.4679 \times 2.4395 = 6.0204$  the whole draught nearly.

How to arrange a drawing-frame with four lines of rollers, putting eight ends into one, with a draught of 1 into 8. The cube root of 8 is 2, equal draught in the three separate places. The front rollers are  $1\frac{3}{8}$  inch diameter; the second, third, and fourth rollers are 1 inch diameter. What will be the number of teeth in the various wheels and pinions necessary to produce the intermediate draughts, and the total or whole draught? The front roller pinion of 26 teeth drives a double carrier wheel of 32 teeth, the double carrier pinion of 27 teeth driving the second roller wheel of 32 teeth.

For a dividend  $1.375 \times 32 \times 32 = 1419 = 2.0071$ , the front

For a divisor  $1 \times 26 \times 27 = 702 =$  draught.

From the following wheels and pinions find the draught between the front and third rollers. Front roller pinion of 26 teeth drives a double carrier wheel of 46 teeth, and the double carrier pinion of 27 teeth drives the third roller wheel of 45 teeth.

For a dividend  $1.375 \times 45 \times 46 = 2846.25 = 4.0544$ , front and

For a divisor  $1 \times 26 \times 27 = 702 =$  middle draughts.

Then  $4.0544 \div 2.0071 = 2.020028$ , middle draught.

If the back or fourth roller wheel of 53 teeth be driven by the third roller pinion of 27 teeth, what will be the back draught, supposing no draught in the carrier wheel?



Divide 53 by  $27 \times 1.9629$ , back draught.

Then multiply the front and middle by the back, will give the whole draught.

Thus  $4.0544 \times 1.9629 = 7.95838$ , whole draught.

Drawing-frames generally have the same amount of draughts as they have in the number of doublings.

### SLUBBING-FRAME.

To find a draught in a slubbing-frame is very similar to that of the drawing-frame. Suppose a slubbing-frame with three lines of rollers requires a draught of one into six for the whole, and to be equally, or nearly so, distributed between the front and middle and back rollers. The front rollers are  $1\frac{1}{4}$  inch diameter, and the middle and back one inch diameter, front roller pinion of 34 teeth driving the double carrier wheel of 100 teeth, the double carrier pinion of 35 teeth driving the back roller wheel of 57 teeth : what will be the whole draught ?

For a dividend  $1\frac{1}{4} \times 57 \times 100 = 7125$  5.9873, the whole  
 For a divisor  $1 \times 34 \times 35 = 1190$  draught.

From the following wheels and pinions find the front draught : The front roller pinion of 27 teeth drives a double carrier wheel of 38 teeth, and the pinion on the double carrier of 27 teeth drives the wheel on the middle roller of 38 teeth.

For a dividend  $1\frac{1}{4} \times 38 \times 38 = 1805$   
 For a divisor  $1 \times 27 \times 27 = 729$  = 2.476, front draught.

Then  $5.9873 \div 2.476 = 2.4181$ , back draught.

Multiply the front by the back, and the product will be the whole draught.

Thus,  $2.476 \times 2.4181 = 5.9871$ , nearly the whole draught.

As the slubbing-frame is the first place where twist is used for binding together and strengthening the roving, to enable it to withstand the strain caused by the friction of the roving on the flyer while winding it upon the bobbin, so is it the last place where a less draught than one into four can be used with advantage. Small draughts, and often repeated, are generally considered the best ; but practical experience in this case is opposed to theory. Intermediate frames, fine roving-frames, and mules, have no draught between the back and middle rollers but what is just sufficient to keep the thread tight, and no more, say  $\frac{1}{36}$ th to  $\frac{1}{24}$ th. The weight on the middle rollers should be at least one-third less than the weight on the back rollers, so that the middle rovers will not have the power to cause the roving to slip between the back rollers, but still be able to keep the roving tight, which is a condition necessary for producing a good roving or good yarn.







From the following particulars find the draught in the rollers of a fine roving-frame. The front rollers are  $1\frac{1}{8}$  inch diameter, and the back rollers 1 inch diameter; the front roller pinion 34 teeth, the double carrier wheel 110 teeth; the double carrier pinion 34 teeth, and the back roller wheel 56 teeth.

$$\begin{array}{l} \text{For a dividend } 1\frac{1}{8} \times 110 \times 56 = 6930 \\ \text{For a divisor } 1 \times 34 \times 34 = 1156 \end{array} = 5.994, \text{ draught required nearly.}$$

## MULE.

A mule spinning 36's with a draw of 66 inches, and a gain of the carriage of 2 inches per draw, and putting up double a roving of  $7\frac{1}{2}$  hank, what will be the roller draught?

| in. hank.      | in. hanks.         |                                           |
|----------------|--------------------|-------------------------------------------|
| 66 : 36 ::     | 64 : 34.909 ; then | 34.909                                    |
|                | 36                 | 2                                         |
|                | <hr/> 384          | <hr/> 7.5)69.818(9.309, draught required. |
|                | 192                | 675                                       |
|                | <hr/> hanks.       | <hr/>                                     |
| 66)2304(34.909 |                    | 231                                       |
| 198            |                    | 225                                       |
| <hr/>          |                    | <hr/>                                     |
| 324            |                    | 680                                       |
| 264            |                    | 675                                       |
| <hr/>          |                    | <hr/>                                     |
| 600            |                    | 5                                         |
| 594            |                    | <hr/>                                     |
| <hr/>          |                    |                                           |
| 600            |                    |                                           |
| 594            |                    |                                           |
| <hr/>          |                    |                                           |
| 6              |                    |                                           |
| <hr/>          |                    |                                           |

From the following particulars find the roller draught of a mule. The front rollers are  $\frac{17}{16}$  of an inch diameter, and the  $\frac{15}{16}$  of an inch diameter; the front roller pinion 27 teeth, double carrier wheel 120 teeth, the double carrier pinion 27 teeth, and the back roller wheel 50 teeth.

$$\begin{array}{l} \text{For a dividend } 17 \times 120 \times 50 = 102000 \\ \text{For a divisor } 15 \times 27 \times 27 = 10935 \end{array} = 9.327, \text{ roller draught.}$$



## CALCULATION OF TWIST.

*Rule.*—To find the twist per inch in roving, multiply the square root of the hank roving by a common multiplier, viz., 1.2, and the product will be the twist per inch required.

## EXAMPLES.

What twist per inch will  $\frac{1}{2}$  hank roving require?

$$\begin{array}{r} \frac{1}{2} = .50(\cdot 707 \text{ square root } \cdot 707 \\ 49 \qquad \qquad \qquad 1.2 \text{ common multiplier.} \\ \hline 1407)10000 \\ \quad 9849 \\ \hline \quad 151 \\ \hline \end{array} \qquad \begin{array}{r} \hline \cdot 8484 \text{ twist per inch required.} \\ \hline \end{array}$$

What twist per inch will  $2\frac{3}{4}$  hank roving require?

$$\begin{array}{r} 2\frac{3}{4} = 2.75(1.658 \text{ square root.} \\ 1 \\ \hline 26)175 \\ \quad 156 \\ \hline 325)1900 \\ \quad 1625 \\ \hline \quad 27500 \\ \quad 26464 \\ \hline \quad 1036 \\ \hline \end{array} \qquad \begin{array}{r} 1.658 \\ 1.2 \text{ common multiplier.} \\ \hline 1.9896 \text{ twist per inch required.} \\ \hline \end{array}$$

What twist per inch will a 16 hank roving require?

$$\begin{array}{r} 16(4 \text{ square root.} \\ 16 \\ \hline \end{array} \qquad \begin{array}{r} 4 \\ 1.2 \text{ common multiplier.} \\ \hline 4.8 \text{ twist per inch required.} \\ \hline \end{array}$$



RULE FOR HOSIERY YARN.

To find the twist per inch in hosiery yarn, multiply the square root of the number of hanks per pound by a common multiplier, viz., 2.5, and the product will be the twist per inch required.

EXAMPLES.

What twist per inch will  $4\frac{1}{2}$  hank hosiery yarn require?

$$4\frac{1}{2} = 4.50(2.12132 \text{ square root.})$$

$$\begin{array}{r} 4 \\ \hline 41)50 \\ 41 \\ \hline 422)900 \\ 844 \\ \hline 4241)5600 \\ 4241 \\ \hline 42423)135900 \\ 127269 \\ \hline 863100 \\ 848524 \\ \hline 14570 \\ \hline \end{array}$$

then 2.12132

2.5 common multiplier.

$$\begin{array}{r} \hline 1060660 \\ 424264 \\ \hline \end{array}$$

5.303300 twist per inch required.

What twist per inch will  $8\frac{1}{2}$  hank hosiery yarn require?

$$8\frac{1}{2} = 8.50(2.9154 \text{ square root.})$$

$$\begin{array}{r} 4 \\ \hline 49)450 \\ 441 \\ \hline 581)900 \\ 581 \\ \hline 5825)31900 \\ 29125 \\ \hline 58304)277500 \\ 233216 \\ \hline 44284 \\ \hline \end{array}$$

then 2.9154

2.5 common multiplier.

$$\begin{array}{r} \hline 145770 \\ 58308 \\ \hline \end{array}$$

7.28850 twist per inch required.



## RULE FOR YARN FOR DOUBLING PURPOSES.

To find the twist per inch in yarn for doubling purposes, multiply the square root of the number of hanks per pound by a common multiplier, viz., 2.75, and the product will be the twist per inch required.

## EXAMPLES.

What twist per inch will 64's for doubling require?

64(8 square root. Then  $8 \times 2.75 = 22$  twist per inch required.

64

—

What twist per inch will 72 hanks per pound require?

72)8.48 square root.

8.48

64

2.75 common multiplier.

164)800

4240

656

5936

1696

1688)14400

23.3200 twist per inch required.

13504

896

What twist per inch will 85 hanks per pound require?

85(9.219 square root.

9.219

81

2.75 common multiplier.

182)400

46095

364

64533

18438

1841)3600

25.35225 twist per inch required.

1841

18429)175900

165861

10039

What twist per inch will 100 hanks per pound require?

100(10 square root.

Then  $10 \times 2.75 = 27.5$ , twist per inch required.



# RULE FOR WEFT YARN.

To find the twist per inch for weft yarn multiply the square root of the number of hanks per pound by a common multiplier, viz., 3.25, and the product will be the twist per inch required.

## EXAMPLES.

What twist per inch will 18 hanks in the pound require ?

18(4.246 square root.

16

82)200

164

844)3600

3376

8482)22400

16964

84846)543600

509076

34524

Then 4.2426

3.25 common multiplier.

212130

84852

127278

13.788450 twist per inch required.

What twist per inch will 38 hanks per pound require ?

38(6.164 square root.

36

121)200

121

1226)7900

7356

12324)54400

49296

5104

Then 6.164

3.25 common multiplier.

30820

12328

18492

20.03300 twist per inch required.



What twist per inch will 64 hanks per pound require ?

|                                                                           |                                                                                                                                 |
|---------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------|
| $\begin{array}{r} 64 \text{ (8 square root.} \\ 64 \\ \hline \end{array}$ | $\begin{array}{r} .8 \\ 3.25 \text{ common multiplier.} \\ \hline 26.00 \text{ twist per inch required.} \\ \hline \end{array}$ |
|---------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------|

### RULE FOR COMMON MULE TWIST.

To find the twist per inch for warp yarn, multiply the square root of the number of hanks per pound by a common multiplier, viz., 3.75, and the product will be the twist per inch required.

#### EXAMPLES.

What twist per inch will 24 hanks per pound require ?

|                                                                                                                                                                              |                                                                                                                                                                                             |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| $\begin{array}{r} 24(4.898 \text{ square root.} \\ 16 \\ \hline 88)800 \\ 704 \\ \hline 969)9600 \\ 8721 \\ \hline 9788)87900 \\ 78304 \\ \hline 9596 \\ \hline \end{array}$ | $\begin{array}{r} \text{Then } 4.898 \\ 3.75 \text{ common multiplier.} \\ \hline 24490 \\ 34286 \\ \hline 14694 \\ \hline 18.36750 \text{ twist per inch required.} \\ \hline \end{array}$ |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

What twist per inch will 42 hanks per pound require ?

|                                                                                                                                                 |                                                                                                                                                                           |
|-------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| $\begin{array}{r} 42(6.48 \text{ square root.} \\ 36 \\ \hline 124)600 \\ 496 \\ \hline 1288)10400 \\ 10304 \\ \hline 96 \\ \hline \end{array}$ | $\begin{array}{r} 6.48 \\ 3.75 \text{ common multiplier.} \\ \hline 3240 \\ 4536 \\ \hline 1944 \\ \hline 24.3000 \text{ twist per inch required.} \\ \hline \end{array}$ |
|-------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------|



What twist per inch will 225 hanks per pound require?

|                                                                                                                                  |                                                                                                                                                                                                                 |
|----------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 225(15 square root.<br>1<br><hr style="width: 10%; margin: 0 auto;"/> 25)125<br>125<br><hr style="width: 10%; margin: 0 auto;"/> | 3.75 common multiplier.<br>15<br><hr style="width: 10%; margin: 0 auto;"/> 1875<br>375<br><hr style="width: 10%; margin: 0 auto;"/> 56.25 twist per inch required.<br><hr style="width: 10%; margin: 0 auto;"/> |
|----------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

What twist per inch will 256 hanks per pound require?

|                                                                                                                                  |                                                                                                                                                                    |
|----------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 256(16 square root.<br>1<br><hr style="width: 10%; margin: 0 auto;"/> 26)156<br>156<br><hr style="width: 10%; margin: 0 auto;"/> | 3.75 common multiplier.<br>16<br><hr style="width: 10%; margin: 0 auto;"/> 2250<br>375<br><hr style="width: 10%; margin: 0 auto;"/> 60.00 twist per inch required. |
|----------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------|

### RULE FOR EXTRA TWIST.

To find the twist per inch in yarn of extra twist multiply the square root of the number of hanks per pound by a common multiplier, viz., 4, and the product will be the twist per inch required.

#### EXAMPLES.

What twist per inch will 32 hanks per pound require?

|                                                                                                                                                                                                                                                     |                                                                                                                                                            |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 32(5.65 square root.<br>25<br><hr style="width: 10%; margin: 0 auto;"/> 106)700<br>636<br><hr style="width: 10%; margin: 0 auto;"/> 1125)6400<br>5625<br><hr style="width: 10%; margin: 0 auto;"/> 775<br><hr style="width: 10%; margin: 0 auto;"/> | Then 5.65<br>4 common multiplier.<br><hr style="width: 10%; margin: 0 auto;"/> 22.60 twist per inch required.<br><hr style="width: 10%; margin: 0 auto;"/> |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------|

What twist per inch will 50 hanks per pound require?

|                                                                                                                                                                                          |                                                                                                                                                       |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------|
| 50(7.07 square root.<br>49<br><hr style="width: 10%; margin: 0 auto;"/> 1407)10000<br>9849<br><hr style="width: 10%; margin: 0 auto;"/> 151<br><hr style="width: 10%; margin: 0 auto;"/> | 7.07<br>4 common multiplier.<br><hr style="width: 10%; margin: 0 auto;"/> 28.28 twist per inch required.<br><hr style="width: 10%; margin: 0 auto;"/> |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------|



What twist per inch will 75 hanks per pound require ?

|                                                                                                                                             |                                                                                                                               |
|---------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------|
| $\begin{array}{r} 75(8.66 \text{ square root.} \\ 64 \\ \hline 166)1100 \\ 996 \\ \hline 10400 \\ 10356 \\ \hline 44 \\ \hline \end{array}$ | $\begin{array}{r} 8.66 \\ 4 \text{ common multiplier} \\ \hline 34.64 \text{ twist per inch required.} \\ \hline \end{array}$ |
|---------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------|

What twist per inch will 85 hanks per pound require ?

|                                                                                                                                                                                    |                                                                                                                                  |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------|
| $\begin{array}{r} 85(9.219 \text{ square root.} \\ 81 \\ \hline 182)400 \\ 364 \\ \hline 1841)3600 \\ 1841 \\ \hline 18429)175900 \\ 165861 \\ \hline 10039 \\ \hline \end{array}$ | $\begin{array}{r} 9.219 \\ 4 \text{ common multiplier.} \\ \hline 36.876 \text{ twist per inch required.} \\ \hline \end{array}$ |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------|

### RULES AND EXAMPLES

*For finding the produce of drawing, slubbing, intermediate, fine roving and spinning.*

What will be the product per week of 48 hours of one delivery of a drawing-frame whose front rollers are  $1\frac{3}{8}$  in diameter, or 4.3197 in circumference, or 330 revolutions per minute, making .1666 decimal hank sliver, or 140 yards to the pound ?

#### RULE A.

Find the inches delivered by the front roller per week, and divide by the inches in one pound of sliver.

#### EXAMPLE.

Thus,  $48\text{hr.} \times 60\text{min} \times 330 \text{ revolutions} \times 4.3197 \text{ circumference}$   
of the front roller =  $\frac{410544}{140\text{yd.} \times 36\text{in.} = 5040} = 814.5\text{lb.}$ , produce per week.

[Continued.]



Or thus, 48 hours per week  
60 minutes per hour

---

2880 minutes per week  
330 revolutions per minute

---

86400  
8640

---

950400 revolutions per week  
4.3197 circumference of front rollers

|           |         |
|-----------|---------|
| Yards 140 | 6652800 |
| 36        | 8553600 |
| <hr/>     | 950400  |
| 840       | 2851200 |
| 420       | 3801600 |
| <hr/>     |         |

5040)4105442.8800(814.5 pounds per week  
40320

---

7344  
5040

---

23042  
20160

---

2882.8  
2520.0

---

362.88 remainder.

If the spindles of a slubbing-frame, for one hank roving, make 500 revolutions per minute, and the quantity of twist per inch being 1.2, what will be the product per spindle per week of 50 hours?

RULE B.

Find the revolutions of the spindles per week for a dividend and multiply the inches in one pound of roving by the twist per inch for a divisor.

EXAMPLE.

Thus, 50 hours  $\times$  60 min.  $\times$  500 revolutions = 1500000  
1 hank = 840 yards  $\times$  36in.  $\times$  1.2 twist = 36288 = 4133lb.

[Continued.]



Or thus, 1 hank = 840 yards

36

$$\begin{array}{r}
 \hline
 5040 \quad 50 \\
 2520 \quad 60 \\
 \hline
 30240 \quad 3000 \\
 1 \cdot 2 \quad 500 \\
 \hline
 \end{array}$$

36288)1500000(41.33lb. produce per week

145152

48480

36288

121920

108864

130560

108864

21696 remainder.

If the spindles of an intermediate-frame revolve at the rate of 677 times per minute for 50 hours per week what will be the produce per spindle making a  $2\frac{1}{2}$  hank roving and putting in 1.89 of twist per inch?

EXAMPLE.

Thus, 50 hours  $\times$  60 minutes  $\times$  677 revol. = 2031000  
 $2\frac{1}{2}$  hanks = 2100 yards  $\times$  36in.  $\times$  1.89 twist  $\frac{14284}{14284}$  = 14.21lb.

Or thus—

840 yards per hank

$2\frac{1}{2}$  hanks per pound

1680

420

2100

36 Inches per yard

12600

6300

75600

50 hours per week

60 minutes per hour

3000

[Continued.]



|                 |                                           |                            |
|-----------------|-------------------------------------------|----------------------------|
| Brought forward | 75600                                     | 3000                       |
| Twist per inch  | 1.89                                      | 677 revolutions per minute |
|                 | <hr/>                                     | <hr/>                      |
|                 | 680400                                    | 21000                      |
|                 | 604800                                    | 21000                      |
|                 | 75600                                     | 18000                      |
|                 | <hr/>                                     | <hr/>                      |
|                 | 142884)2031000(14.21lb. produce per week. |                            |
|                 | <hr/>                                     | <hr/>                      |

If the spindles of a fine roving-frame revolve at the rate of 893 times per minute for 52 hours per week what will be the produce per spindle making a  $7\frac{1}{2}$  hank roving and putting in 3.28 turns of twist per inch?

EXAMPLE.

Thus, 52 hours  $\times$  60 minutes  $\times$  893 revol. = 2786160  
 840 yards  $\times$   $7\frac{1}{2}$  hanks  $\times$  36in.  $\times$  3.28 twist =  $\frac{2786160}{743904}$  = 3.745lbs.

|          |                                  |       |
|----------|----------------------------------|-------|
| Or thus— | 840 yards                        |       |
|          | $7\frac{1}{2}$ hanks             |       |
|          | <hr/>                            |       |
|          | 5880                             |       |
|          | 420                              |       |
|          | <hr/>                            |       |
|          | 6300                             |       |
|          | 36                               |       |
|          | <hr/>                            |       |
|          | 37800                            |       |
|          | 18900                            |       |
|          | <hr/>                            |       |
|          | 226800                           |       |
|          | 3.28                             | 52    |
|          | <hr/>                            | <hr/> |
|          | 1814400                          | 60    |
|          | 453600                           | 3120  |
|          | 680400                           | 893   |
|          | <hr/>                            | <hr/> |
|          | 743904)2786160(3.745lb., produce |       |

[Continued.]



743904)2786160(3.745lb. produce  
2231712

---

5544480

5207328

---

3371520

2975616

---

3959040

3719520

---

239820 remainder.

---

What will be the produce per spindle of a mule spinning 36's twist with 22.5 turns of twist per inch, spindles revolving at the rate of 7000 times per minute, and working 58 hours per week, deducting  $6\frac{1}{2}$  per cent from the speed of the spindles as an allowance for time taken up in winding on the yarn, &c.? The produce to be given in ounces and decimal parts of an ounce.

To reduce 7000 by  $6\frac{1}{2}$  per cent, multiply them together and deviate by 100, or cut off two places on the right hand.

Thus 7000

$6\frac{1}{2}$

---

42000

3500

---

455.00

---

Then  $7000 - 455 = 6545$

455

---

Average 6545 speed per minute.

---

### RULE C.

Take  $6\frac{1}{2}$  per cent from the speed of the spindles, and multiply the minutes per week by the new found speed, and by 16 to reduce into ounces for a dividend, and divide by the inches in a pound of yarn, multiplied by the twist per inch.

### EXAMPLE.

| Speed.     | Per cent.        | Speed.          | Min.                | oz.                                                |
|------------|------------------|-----------------|---------------------|----------------------------------------------------|
| Thus: 7000 | $- 6\frac{1}{2}$ | $= 6545$        | $\times 3480$       | $\times 16 = 364425600$                            |
| 36 hanks   | $\times 840$ yd. | $\times 36$ in. | $\times 22.5$ twist | $= \frac{364425600}{24494400} = 14.87 \text{ oz.}$ |

[Continued.]



|                 |                 |  |                            |
|-----------------|-----------------|--|----------------------------|
| Yards per hank  | 840             |  |                            |
| Hanks per pound | 36              |  |                            |
|                 | <u>5040</u>     |  | 58 hours per week          |
|                 | 2520            |  | 60 minutes per hour        |
|                 | <u>30240</u>    |  | 3480 minutes per week      |
|                 |                 |  | 6545 average rev. per min. |
| Inches per yard | 36              |  |                            |
|                 | <u>181440</u>   |  | 17400                      |
|                 | 90720           |  | 13920                      |
|                 | <u>1088640</u>  |  | 17400                      |
|                 |                 |  | 20880                      |
| Twist per inch  | 22.5            |  |                            |
|                 | <u>5443200</u>  |  | 22776600                   |
|                 | 2177280         |  | 16 oz. per lb.             |
|                 | 2177280         |  |                            |
|                 | <u>24494400</u> |  |                            |
|                 |                 |  | 364425600(14.87oz.         |
|                 |                 |  | 24494400                   |
|                 |                 |  | <u>119481600</u>           |
|                 |                 |  | 97977600                   |
|                 |                 |  | <u>215040000</u>           |
|                 |                 |  | 195955200                  |
|                 |                 |  | <u>190848000</u>           |
|                 |                 |  | 171460800                  |
|                 |                 |  | <u>193872, remainder.</u>  |

What will be the produce per spindle per week of 58 hours of a mule spinning 36's weft yarn, with 19.5 revolutions of twist per inch, and the spindles revolving at the rate of 7000 times per minute,  $7\frac{1}{2}$  per cent being deducted from the speed of the spindles to allow for winding on the yarn, doffing the cops, and other stoppages.

EXAMPLE

Thus:  $58\text{hr.} \times 60\text{min.} \times 6475 \text{ revol.} = 22533000$   
 $36 \text{ hanks} \times 840\text{yards} \times 36\text{in.} = 19.5 \text{ twist} = \frac{22533000}{21228480} = 1.061\text{lb.}$

[Continued..]



Or thus—

Take  $7\frac{1}{2}$  per cent from the speed of the spindles, as an allowance for winding on the yarn, doffing the cops, and other stoppages.

Speed of spindles 7000 per minute.

Per cent  $7\frac{1}{2}$

49000

3500

525.00 Then  $7000 - 525 = 6475$ , speed, minus  
per cent.

Yards per hank 840

Hanks per lb. 36

5040

2520

30240

Inches per yard 36

181440

90720

1088640

Inches per lb. 1088640

Twist per inch 19.5

5443200

9797760

1088640

58 hours per week.

60 minutes per hour.

3480 minutes per week.

6475 speed, minus per centage.

17400

24360

13920

20880

22533000 revolutions per week.

16 ounces per lb.

15198000

22533000

Divisor 21228480 ) 360528000 (16.98 ounces per week.  
21228480

148243200

127370880

208723200

191056320

176668800

169827840

6840960



















Hyde, James

The science of cotton spinning practically arranged and simplified Giving  
a plain, practical and comprehensive detail of the various departments of  
blowing, carding, drawing

Manchester [ca. 1860]

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